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FIFTH

ANNUAL REPORT

OF THE

BOARD OF PUBLIC WORKS

City of Duluth, Minn.,

For the Year Ending Feb. 29. 1892.

Including a Plan for a Draw Bridge Across the Ship Canal
by Arentz & Sangdahl, Civil Engineers,

—AND—

A Report of the Board of Government Engineers Appointed
to Investigate the Matter of the Construction of the Bridge.

DULUTH, MINN.:
Press of T. J. Hunter,
1892.

MEMBERS AND OFFICERS

OF THE

Board of Public Works.

MEMBERS.

Nils Nillson	Term Expires March, 1893
Henry Truelsen	Term Expires March, 1894
James Farrell	Term Expires March, 1895

OFFICERS.

President	Henry Truelsen
Clerk of the Board	Thurlow W. Abell
City Engineer	Edw. H. Keating
Assistant Office Engineer	M. W. Lewis
Assistant Field Engineer	D. A. Reed
Stenographer	R. Murchison

Report of the Board of Public Works.

Office of the Board of Public Works.
City of Duluth, April 30, 1892.

To the President and Common Council of the City of Duluth:

Gentlemen:—We submit herewith for your consideration the reports made to the Board by the Clerk of the Board and the City Engineer for the year ending February 29, 1892.

They show in detail the work contracted and accomplished, together with other interesting data relative to the progress and growth of the city in the line of public improvements.

As shown in the above reports you will see that the past year there was a very large amount of work done. The relations of the Board with the different contractors was, with one exception, very satisfactory. In this one case the root of the trouble was the fact that the Board awarded more contracts to one firm than they could successfully attend to and push to completion by the time stated. This was no fault of the Board, as it has always been the custom to award contracts to the lowest responsible bidder, and they were considered responsible as long as they furnished the required bonds. To avoid hereafter such trouble as was experienced last year, we would respectfully recommend that in the future if the lowest bidder for an improvement is found to be a contractor or a firm who already have contracts with the city, which in the opinion of the Board is all they can do successfully, that the Board shall have the power to consider the bidder is not "a responsible bidder" and reject his proposal. In other words that the Board shall have the authority to determine to what limit the reliability of a contractor extends, and beyond that he shall not be entitled to receive any additional contracts. If the work awarded to Messrs. Davis & Cooper last year had been divided among two or three contractors it is very probable that it would all have been completed by the stated time instead of all being in an unfinished condition—the time of completion having been extended to July 1, 1892.

The Board would respectfully call the attention of the Council to the subject of contemplated improvements the coming year. We would suggest that petitions for any kind of an improvement, without it represents a majority of the property benefited, be not considered excepting in cases where an improvement is absolutely necessary for the public good. The past year we have had a good deal of trouble making certain assessments for expensive work. Before making the assessments, we have carefully considered the matter of benefits and have made the assessments as in our opinion we thought just and fair, but nevertheless in two or three cases the making of the assessments were very strongly opposed, with the result that we were obliged to make them over. It seems to us that the foundation of all this trouble is the fact that property owners have been "assessed to death" and we would therefore respectfully recommend that improvements the coming year be ordered with caution and after careful consideration. Let the taxpayers have a rest and a chance to recuperate their bank accounts.

The contracts which were originally awarded to Forrestal Bros. have all been completed. The Fourth street contract which, after the assignment of Forrestal Bros., was taken in charge and carried on by their bondsmen and afterwards abandoned by them was finished by the city the past year and the amount due thereon after deducting the cost of completion was paid F. J. Voss, receiver of Messrs. Bell and Anderson, bondsmen for Forrestal Bros. This amount, although insufficient to pay in full all the labor claims against said work was by him distributed pro rata among the laborers who had not yet received their pay. The contract for the paving of Bench street from Eighth avenue east to Montana avenue was abandoned also by the bondsmen and was completed by the city the past year at a loss of $82.23. The improvement of Superior street from Virginia avenue to the north city limits was relet to L. Meining & Son and the cost of completing the work over what it would have amounted to had the improvement been finished by Forrestal Bros., was $17,062.76. The Ohio avenue contract for the improvement of said avenue from Lake Superior to Eighth street was relet to Messrs. Hogan and Campbell and the cost of finishing that contract over what it would have amounted to at Forrestal Bros. prices was $2,338.08. A summary of these amounts shows that the city is a loser to the amount of $19,483.07, as the assessments for the different improvements had to be made on the basis of what the cost would have been had Forrestal Bros. completed their contracts.

A matter which seems of great importance to us is the matter of the construction of sanitary and storm sewers and outlets for same, and the mode of making assessments to pay for them.

The making of assessments for such improvements is one of the most difficult problems which the Board has to contend with. A feasible plan it seems of getting around this trouble has suggested itself to us and we respectfully submit it herewith to your honorable body.

We think that the city should be divided into districts called "sewer districts," and that an estimate as near accurate as possible be made by the City Engineer of the cost of constructing the sewers in each of said districts. After the cost of building the sewers has been estimated it is proposed to divide the amount pro rata upon all the lots in each district, thus equalizing the cost. It seems to us that an injustice is being done when one lot is assessed $150 and the lot next to it $225, the difference caused by there being rock excavation in front of the latter lot. The benefit to one lot derived from having sewer connections is no more than to the other, and consequently it does not seem fair that it should pay more than its neighbor. It is the same case in the matter of assessing for outlet, it hardly seems right to assess a lot on Nineteenth street for the construction of an outlet sewer in Second alley when there is no immediate benefit received, nor can any one say when they would be likely to receive benefits from such an outlet. We would, therefore, recommend as follows: That at the next session of the Legislature an act be passed granting the city authority to create a "sewer fund" and the division of the city into sewer districts for the purpose of equalizing assessments. It is proposed to pay for the construction of all the sewers out of this fund and all the monies received from assessments to pay for same will be credited to it; thus the fund after once capitalized will be self-sustaining. By this system property owners will know just what their sewer will cost them, and there can not be any grounds for a "kick." The making of the assessments will be comparatively easy as each lot will be assessed the same. Assessments for outlets will not be made until the property proposed to assess has a direct benefit. We hope your honorable body will carefully consider these suggestions, and if they meet with your approval, that you will see that measures towards relief are taken at as early a date as possible.

SHIP CANAL BRIDGE.

October 19, 1891, the Board recommended to the Common Council the necessity of bridging the ship canal on Lake avenue and asked that authority be granted them to advertise for competitive plans and specifications for a drawbridge for the accommodation of railroad, wagon and foot travel. November 9, 1891, the Council granted the above authority, also the power to offer a cash prize of $1,000 for the best plans submitted.

Pursuant to the above authority granted the Board by the Common Council, a "Notice to Architects" was published in the official paper of the city and in the Engineering News of New York that the Board would on the 28th day of December, 1891, receive plans and specifications for a draw-bridge across the ship canal on Lake avenue and would award a prize of $1,000 for the best plans submitted.

Plans were submitted by twenty different competitors from all over the country.

The annexed table gives all the details relating to the plans received:

After a careful consideration by the board with the assistance of the city engineer, of all the plans submitted, the board decided that the plans of Messrs. Arentz & Sangdahl of Milwaukee, Wisconsin, were the best and most carefully studied design for a draw-bridge proper, and they were entitled to receive the $1,000.00 prize.

A cut showing the plan of the bridge, with an estimate of the cost will be found elsewhere in this report.

While the board were satisfied that the bridge, if built, would answer the purpose for which it was intended, they were also quite sure that a bridge which would take care of the business for several years, or until such a time as the city felt it was able to tunnel the canal, could be completed for at least one-half of what it would cost to build Arentz & Sangdahl's bridge. January 18, 1892, the Board recommended to the Common Council that J. A. L. Waddell's plan for a lift-bridge be adopted, it being, in the opinion of the Board, the best adapted to the locality and the most suitable and economic structure as regards both construction and operation.

The plans of Mr. Waddell were adopted by the council and a committee consisting of J. W. Miller, harbor master, S. A. Thompson, secretary of the Chamber of Commerce, and Henry Truelsen, president of the Board of Public Works, was sent to Washington to lay the plans before the Secretary of the War Department and if possible get his consent to the construction of the bridge. Upon presenting themselves before the Secretary of War the committee were informed that a protest against the construction of the bridge had been filed with the Department, and that before giving his decision relating thereto, a committee of Government Engineers would be appointed to hear the petitions for and the objections to the construction of said bridge. This was all that the committee could do at this time, and Mr. Truelsen returned to Duluth, Mr. Miller and Mr. Thompson remaining in Washington for a time to lobby for other interests of the city.

Later on, the Board of Public Works were notified by the War Department that a Board of Engineers had been appointed, composed of Col. O. M. Poe, Maj. Wm. Ludlow and Maj. W. A. Jones, and that they would meet in Detroit, Michigan, on Monday, March 2, 1892, and all persons interested were invited to be present, when an opportunity would be given them to be heard. The council were informed of this notice, and Chas. A. Long, alderman, S. L. Smith, city attorney, J. W. Miller, harbor master, S. A. Thompson, secretary of the Chamber of Commerce, and Henry Truelsen, president of Board of Public Works, were delegated as representatives of the city of Duluth to go to Detroit and present arguments in favor of the bridge. At the meeting the construction of the bridge was strongly opposed by Capt. Alex. McDougall of the American Steel Barge Co., the Cleveland Vessel Owners' Association, the Lake Carriers' Association, and others. Each one of the city's delegates presented strong arguments in favor of the bridge. They were fully confident that the authority would be granted, although they were satisfied that one or two of the government officials were opposed to its construction. The delegates were before the Board of Engineers three days. Their arguments were presented in typewritten form, and upon the conclusion of the hearing, the board announced that their decision would be withheld a few days until they could carefully consider all the facts presented.

DESIGNS FOR DRAW BRIDGE ACROSS SHIP CANAL, DULUTH, MINN.

DESIGNER.	No. of Drawings.	Description of Bridge.	ESTIMATED COST.					Length of Main Bridge in Feet.	Total Length of Bridge Works in Feet.	POCKET SPAN TO ROLL SIDEWISE.		Time to Open.	H. P. to Operate.	REMARKS.
			Super-structure.	Sub-structure.	Machinery.	Contingencies.	Total.			No.	Length.			
Olaff Hoff Minneapolis, Minn	3	Single Sliding Draw	$193,390	$139,420			$333,000	588	854	1	265	3 minutes	40	$333,000 with granite masonry; $310.000 with Lake Superior sandstone.
W. L. Stebbins Chicago, Ill	4	Whaleback	135,000				135,000	250	525			2 min		Breakwater to protect bridge against heavy seas, estimated cost, $80,000, making a total cost of $215,000.
Keepers & Riser Clinton, Iowa	5	Double Lift Sliding Draw					180,000	432				3½ min	35	
J. N. Ostrom and Thomas E. Brown New York	9	Hinged Draw	42,400 44,000	18,900 19,600	$ 62,000 62,000		123,000 125,600	254 254	508 508			1½ to 3 min	50 50	
Sooysmith & Co. New York	1	Double Lift Sliding Draw	95,287	84,056	11,000		190,343	528	792			3 to 4 min		$190,343 is the estimate for a clear height of 20 feet above water. If the clear height is only 8 feet, esti-cost is $162,203. Design shows wooden stringers.
H. Breen	2	Single Sliding Draw	36,500	42,500	21,000		100,000	255	510			3 min		Supporting pier of bridge runs on track at bottom of canal.
Chas. Steiner Chicago, Ill	1	Hinged Draw						250						
John A. Roebling Sons Co New York	1	Double Lift	40,000				40,000	260						
J. A. L. Waddell Kansas City, Mo	3 1	Double Sliding Draw Single Lift	110,500 71,350	36,000 22,800	 5,000	$ 7,500 5,000	154,000 104,150	520 260	780 340	2	130	2 to 3½ min 1 to 2 min	 15 deep	
*F. C. H. Arentz—L. E. Shangdahl Milwaukee, Wis	11	Single Sliding Draw	110,500	90,000	35,000		236,000	(B) 538 (A) 608	(B) 800 (A) 870			1¼ min	116	Two designs (A), railroad track on level with street; (B), railroad track overhead.
O. Sanne—W. N. Finley Milwaukee, Wis	4	Single Sliding Draw	88,000	24,000	15,000	13,000	140,000	406	551	1	145	3 min		
J. L. White Duluth	1	Single Sliding Draw	105,000		6,000		111,000	333	583			1½ min	200	
A. S. Cooper West Superior, Wis	2	Single Sliding Draw	55,738	12,592	1,000	6,933	76,263	396	656			2½ to 5 min	8	
J. A. McNicoll Providence, R. I	1	Single Sliding Draw	125,000				125,000	550	810			5 min		
E. B. Jennings Springfield, Mass	2	(A) Double Hor. Swing (B) Double Vert. Swing					170,000 200,000	560 510	560 510			1½ min 1½ min		
S. W. Frescoln New York	1	Double Sliding Draw	88,400	110,200	29,800	15,500	243,900	550	810			2 to 3 min	70	
R. E. McMath & Sons Detroit, Mich	1	Double Hor. Swing	99,000	72,000		19,000	190,000	490	490			1¼ min		
Benj. LaRue—L. D. Grosvenor Jackson, Mich	1	Double Hor. Swing					108,000	318	318			2½ min		One end of this bridge rests on a propellor when the bridge is opened.
Lindman & Hilleker Minneapolis, Minn	1	Tunnel					500,000							Double tube.
E. E. Strothman West Superior, Wis	1	Tunnel					125,000							Single tube.

*Successful Competitors.

April 6, 1892, the Board of Engineers submitted their report to Gen. Thos. L. Casey, Chief of Engineers of U. S. A., and a copy of all the arguments relating thereto. A few days afterwards we received a communication from the War Department stating that it was adverse to the construction of *any* bridge over the ship canal at Duluth. The decision of the War Department was a great disappointment to this Board. They deeply realized the very great necessity of some mode of railway connection with Minnesota Point, and as the city's finances are rather low the scheme of a bridge, which could be constructed at a cost not to exceed $150,000.00, seemed the only way out of the difficulty. But now there is only one alternative, and that is to tunnel the canal. This means the expenditure of a large amount of money, and without some outside parties come to the rescue and construct a tunnel from funds of their own, the day when we shall have access to Minnesota Point is probably a long way off. A copy of all arguments, report of the Board of Engineers, etc., as published by the United States Senate, will be found elsewhere in this report.

LAKE AVENUE.

The improvement of Lake avenue from Superior street to the ship canal is a subject which has been discussed by the Board and Common Council until it has become a by-word. We are not able to state exactly when the first steps toward this much needed improvement were taken, but at any rate it was two or three years ago. Last summer this Board decided that public necessities demanded its immediate completion and they proceeded to at once grind it through the city mill. After having advertised the work several times for bids, a contract for its construction was finally entered into with Fredin & Wilson, December 21, 1891. Upon the signing of this contract a great load was taken from the minds of the Board. They had been worried a great deal by having been obliged to re-advertise the work so many times, caused necessary by little irregularities continually creeping into the proceedings, which they were afraid would, when we came to make an assessment be brought up and make the whole business illegal. In the early part of the present month it was brought to the notice of the Board that Mr. C. W. Wilson one of the firm of Fredin & Wilson, was a member of the Board of Fire Commissioners and that according to Chapter 3, Section 13 of the City Charter, no officer or employe of the city can be a contractor of, or interested in any contract with the city. This new obstacle in the way of this work was a very serious one in the minds of the Board and they immediately summoned the City Attorney for his advice. After considering the matter he informed the Board that according to the City Charter the contract was certainly null and void and that it would be necessary to again advertise the work. The difficulties arising from this were numerous. Fredin & Wilson had commenced work on the street, they had purchased a large amount of material required and other details in relation thereto, all tending to make the fact that the work would have to be readvertised a very serious matter.

At the time of awarding the contract to Messrs. Fredin & Wilson, while the Board were all familiar with the provision of the Charter as to who should have city contracts, not one of them knew that Mr. Wilson was a Fire Commissioner. The matter has been referred to the Council for them to act on and it is hoped that very soon some plan will be suggested whereby the work can be proceeded with.

A careful perusal by you of the reports appended hereto is invited, and to the suggestions embodied therein we request your attention.

Respectfully submitted,

HENRY TRUELSEN,
W. W. DAVIS,
NILS NILLSON,
Board of Public Works.

ANNUAL REPORT

—OF THE—

CLERK OF THE BOARD

For Year Ending February 29, 1892.

Report of the Clerk of the Board.

Duluth, Minn., April 30, 1892.

To the Board of Public Works of the City of Duluth:

Gentlemen:—Herewith I submit, for your consideration, a report of the business of the Board transacted during the year ending February 29, 1892.

I also hand you herewith tabulated statistics showing the actual amount and cost of all the different kinds of improvements made during the same period, and other information, over which the Board has supervision.

CONTRACTS.

Twenty contracts were signed for grading, paving and otherwise improving the streets, avenues and alleys of the city, the estimated cost of which, at contract prices, amounted to $661,309.27. Upon these contracts work was performed amounting to the sum of $662,983.41.

The cost of finishing the contracts not yet completed will probably not exceed the sum of $30,000.00. This excessive cost over and above the contract prices, as based on the engineer's estimate is accounted for principally by the fact that there was an extra amount of earth excavation in the contract of Louis Meining & Co., for the improvement of London Road from Virginia avenue to the north city limits, and also in the contract of E. J. Amory for the improvement of Piedmont avenue east, from Michigan street to the north line of Third division, there was a large amount of extra rock excavation, and retaining walls built, which it was found necessary to conconstruct.

Details relative to these contracts are shown in Exhibit "A."

For the construction of storm sewers nine contracts were entered into, the estimated cost thereof being $130,733.75. Under this head there was $119,195.43 worth of work performed, one contract being still unfinished. Exhibit "B" shows a summary of these contracts.

Fourteen contracts were entered into for sanitary sewers, the estimated cost thereof being $56,530.47. Two of these contracts still remain unfinished. The amount actually expended for sanitary sewers, as shown by final estimates, amounted to $80,728.06. Exhibit "C" gives the principal details concerning these contracts.

Thirty-four contracts were entered into for the construction of sidewalks, of which Exhibit "D" gives the principal details. The total expenditure for this class of work, including amount paid out of the general fund for the construction of crosswalks being $17,483.45.

Miscellaneous contracts to the number of fourteen were entered into for the sprinkling of streets, construction of timber approaches to the Sixth avenue west viaduct, building of crosswalks, etc. The amount expended for the completion of these contracts amounted to $17,994.15. Detail particulars will be found in Exhibit "E."

A summary of the above mentioned exhibits shows the following results, viz:

Grading, paving, etc	$662,983 41
Storm sewers	119,195 43
Sanitary sewers	80,728 06
Sidewalks	17,483 45
Sprinkling streets	5,073 00
Crosswalks	1,678 15
Miscellaneous	16,316 00
Total amount of work contracted	$903,457 50

CLASS OF WORK.	PRICE 1888.			PRICE 1889.			PRICE 1890.			PRICE 1891.		
	Highest.	Lowest.	Average.	Highest.	Lowest.	Average.	Highest.	Lowest.	Average.	Highest.	Lowest.	Average.
Earth excavation, per cubic yard	$ 40	20	$ 30	$ 40	$ 20	28	40	10	34	60	22	34
Rock excavation, per cubic yard	1 80	1 50	1 64	4 50	50	1 66	5 00	50	1 55	2 50	40	1 53
Borrow, per cubic yard	50	20	37	45	1	31	49	35	40	60	20	39
Gravel and rolling, per cubic yard	1 30	90	1 01	1 00	50	78	1 00	70	1 30	1 25	70	97
Loam, per cubic yard	65	40	54	55	40	48	65	30	54	1 50	50	81
Telford macadam, per square yard	......	......	1 00	......	......	90	1 30	88	1 09	1 10	9	1 00
Cedar block paving on concrete, per square yard	1 92	1 92	1 92	......	......	......	......	......	......	1 80	1 80	1 80
Cedar block paving on sand, per square yard	87	87	87	1 19	93	1 07	1 25	88	1 07	1 05	93	97
Cedar block paving on Telford macadam foundation, per square yard	......	......	......	......	......	......	1 27	1 12	1 18	1 40	1 40	1 40
Rough stone paving for gutters, per square yard	1 50	1 50	1 50	1 28	50	83	1 10	75	93	1 25	65	96
Rough stone paving in Portland cement, per sq.yd	......	......	......	1 60	1 25	1 43	2 25	1 20	1 89.	2 50	1 25	1 96
B. M. pine timber in place, per M	22 00	15 00	19 10	20 00	15 00	17 46	20 00	15 00	17 00	25 00	15 00	19 52
B. M. oak timber in place, per M	......	......	......	......	......	......	......	......	......	45 00	31 00	38 00
Piles in place, each	6 00	6 00	6 00	......	......	......	4 00	2 90	3 45	4 75	3 00	4 08
Piles in place, per lin. ft	......	......	......	41	41	41	......	......	......	18	16½	17¼
Granite curbing, per lin. ft	1 44	1 40	1 42	......	......	1 40	1 25	1 00	1 10	1.45	88½	1 11
Sandstone curbing, per lin. ft	......	......	......	93	83	88	85	60	73	1 00	60	81
Crushed rock, per cubic yard	......	......	......	......	......	......	......	......	......	2 75	1 50	2 17
Tar, per gallon	......	......	......	......	......	......	......	......	......	13	10	12
Rip Rap, per cubic yard	......	......	......	......	......	......	......	......	......	2 00	1 60	1 86
Removing and relaying sidwalks, per lin. ft	15	05	10	10	5	7⅛	10	4	7	20	2	13
Cast iron, per lb	5	04	4½	4	3	3½	6	3	4	25	3	7
Earth excavation in sewer, per cubic yard	1 00	50	70	80	35	49	70	35	57	1 00	15	58
Rock excavation in sewer, per cubic yard	5 75	3 00	4 17	4 50	50	2 61	5 60	1 50	3 89	7 50	50	4 13
44-inch concrete sewer, per lin. ft	......	......	......	......	......	......	......	......	......	4 30	4 30	4 30
44-inch concrete combined sewer, per lin. ft	......	......	......	......	......	......	......	......	......	4 80	4 80	4 80
40-inch concrete combined sewer, per lin. ft	......	......	......	......	......	......	......	......	......	4 40	4 40	4 40
30-inch concrete combined sewer, per lin. ft	......	......	......	......	......	......	......	......	......	3 50	3 50	3 50
26-inch Delta combined sewer, per lin. ft	......	......	......	......	......	......	......	......	......	1 80	1 80	1 80
26-inch Delta sewer, per lin. ft	......	......	......	......	......	......	......	......	......	2 25	1 46	1 86
24-inch pipe in concrete, per lin. ft	2 48	2 23	2 35	2 50	2 00	2 30	2 50	1 25	2 10	3 00	3 00	3 00
21-inch pipe in concrete, per lin. ft	2 00	1 45	1 70	2 30	2 00	2 18	2 00	1 00	1 66	4 00	4 00	4 00
20-inch sewer pipe, laid in concrete, per lin. ft	1 90	1 75	1 83	1 95	1 60	1 82	2 50	1 00	1 91	2 00	2 00	2 00
18-inch sewer pipe, laid in concrete, per lin. ft	1 60	98½	1 37	1 90	1 30	1 57	2 00	85	1 60	2 25	1 60	1 85
15-inch sewer pipe, laid in sand, per lin. ft	......	......	......	75	55	63	85	30	60	90	55	69
12-inch sewer pipe, laid in sand, per lin. ft	74½	39	53	75	50	58	65	20	46	75	40	53
10-inch sewer pipe, laid in sand, per lin. ft	50	34	43	60	16	44	36	20	30	75	42	53
9-inch sewer pipe, laid in sand, per lin. ft	39½	28	35	62	30	38	40	16	28	45	29	37
8-inch sewer pipe, laid in sand, per lin. ft	30	24	27	40	25	29	70	15	25	40	26	34
6-inch sewer pipe, laid in sand, per lin. ft	25	25	25	25	10	18	22	14	18	30	18	24
2 ft. 4 in. by 3 ft. 6 in. brick sewer, per lin. ft	......	......	......	......	......	......	......	......	......	3 25	3 25	3 25
2 ft. 2 in. by 3 ft. 3 in. brick sewer, per lin. ft	......	......	......	......	......	......	......	......	......	4 75	3 00	3 88
1 ft. 10 in. by 2 ft. 9 in. brick sewer, per lin. ft	......	......	......	1 55	1 55	1 55	......	......	......	2 25	2 25	2 25
Sewer brick, per M	20 00	14 00	18 10	20 00	17 00	17 75	18 00	15 00	17 00	25 00	17 00	20 27
Cut stone masonry, per cu. yd	25 00	18 00	20 20	25 00	15 00	21 75	25 00	13 00	20 00	25 00	18 00	22 73
Mortar rubble masonry, per cu. yd	5 00	3 75	4 25	4 50	80	3 08	5 00	3 00	4 10	7 50	4 00	4 87
Portland masonry, per cu. yd	......	......	......	......	......	......	......	......	......	6 00	4 75	5 25
Pine hammered work, per sq. ft	1 00	25	78	40	25	33	1 00	30	52	35	20	26
No. 1 intakes, each	69 96	30 00	44 99	55 00	40 00	48 00	60 00	30 00	44 00	60 00	30 00	47 12
No. 2 intakes, each	80 00	30 00	52 97	50 00	35 00	39 20	40 00	30 00	33 75	60 00	20 00	41 86
No. 3 intakes, each	......	......	......	......	......	......	......	......	......	50 00	40 00	43 33
No. 5 intakes, each	90 00	48 48	62 12	50 00	30 00	38 33	......	......	......	70 00	60 00	65 00
No. 3 catch basins, each	72 75	55 00	63 87	......	......	......	......	......	......	60 00	40 00	50 00
Manholes, each	90 00	25 00	64 18	95 00	38 00	51 76	75 00	25 00	48 00	75 00	40 00	54 66
Automatic flushing tanks, each	......	......	......	125 00	85 00	100 31	120 00	50 00	80 00	140 00	100 00	117 00
Lampholes, each	20 00	8 00	13 16	......	......	18 00	20 00	8 00	14 00	30 00	10 00	20 00
Inlets, ⅛ bends, each	5 00	1 14	2 48	3 00	90	1 40	2 00	25	1 10	3 00	30	1 48

ASSESSMENTS.

Special assessments to cover the cost of the various improvements were made during the year, as follows:

For improvements of streets, avenues and alleys	$409,570 18
For the construction of storm sewers	57,389 13
For the construction of sanitary sewers	79,475 89
For the construction of sidewalks	15,805 30
Total special assessments	$562,240 50

Exhibits "D" "F" "G" and "H" give the principal items concerning these assessments.

CONTRACT PRICES.

Prices bid during the year averaged somewhat higher than for the previous year, as shown by the table annexed hereto.

Easements for slopes for cuts and fills and for retaining walls for use in the improvement of streets have been acquired by condemnation proceedings under Chapter 6 of the Chartar as amended in 1889. The following is a list of such acquirements as were made during the year ending February 29, 1892, viz:

Second street, from Thirteenth avenue east to Sixth avenue west; Second alley, from Eighteenth avenue west to Twenty-fourth avenue west; Superior street, from Twenty-first avenue west to Grand Forks avenue; Piedmont avenue east, from Superior street to the north city limits; Twenty-third avenue west, from Second street to Ninth street; Pennsylvania avenue, from South street to Fourth street; Ninth avenue east, from Superior street to Eleventh street; Oregon avenue, from Lake Superior to Fourth street; Second street, from Seventeenth avenue west to Grand Forks avenue; Jefferson street, from Thirteenth avenue east to Montana avenue; Second alley, from Ninth avenue east to Thirteenth avenue east; Third street, from Twenty-eighth avenue west to west city limits; Fifth alley, from Eighth avenue west to Ninth avenue west.

STREET LIGHTING.

The service given the city during the past year by the Hartman Electric Company has been very satisfactory. The following table gives all the information relating thereto:

MONTH.	No. of Arc Lamps in Operation During Entire Month.	New Lamps Added During the Month.	Total Number of Lamps Reported not Burning During the Month.	Forfeiture Deducted for Lamps Not Burning.	Net Cost of Service.
March	199	1	40¾	$ 30 61	$ 2,080 39
April	200		63	44 08	2,005 92
May	200		171½	120 05	1,998 28
June	200	6	24	16 80	2,067 05
July	206		40¼	28 16	2,153 92
August	206		19	13 30	2,168 43
September	206	1	46½	32 55	2,083 78
October	207	1	44	30 80	2,165 20
November	208		63¼	44 27	2,085 73
December	208	1	76½	53 55	2,150 79
January	209		29	20 30	2,191 04
February	209		14½	10 15	2,058 52
Totals			632¼	$444 62	$ 25,109 05

It will be noted from this table that the number of lights and the cost of same was not increased much over the previous year, the increase in number being only ten and in cost $1,698.10. With the exception of Park Point, which is lighted by kerosene lamps, the city is lighted entirely by the Hartman Electric Company. The prices paid per lamp per night are 35 cents each for the first one hundred lamps and 33⅓ cents for each additional lamp over one hundred. The price paid by this city for electric lighting is very cheap, especially when you take into consideration the fact that this company use coal for producing their power.

In Rochester, N. Y., the companies have water power, which costs almost nothing, and they receive from the city 45 cents per lamp per night, or 25 per cent. more than the city of Duluth pays.

CITY BUILDINGS.

During the year just passed with the exception of two or three small tool houses there have been no city buildings constructed under the direct supervision of the Board.

PLATS.

Sixteen plats of new additions to the city have been examined and approved by the Board, as follows:

Woodland Park, Second Division	40 acres	approved June 1, 1891
Grove Hill Park	10 acres	approved June 1, 1891
Ray's Annex to Portland	5 acres	approved Sept 21, 1891
Windermere	50 acres	approved Oct 9, 1891
Hunter's Park, First Division	36 acres	approved Sept. 21, 1891
Duluth Heights, Fifth Division	74 acres	approved July 1, 1891
Glen Avon, First Division	68 acres	approved Oct. 28, 1891
Glen Avon, Second Division	34 acres	approved Oct. 28, 1891
Glen Avon, Third Division	42 acres	approved Oct. 28, 1891
Glen Avon, Fourth Division	42 acres	approved Sept. 17, 1891
Sterling	10 acres	approved June 29, 1891
Wooster	10 acres	approved June 29, 1891
Motor Line Park	10 acres	approved Nov. 9, 1891
Chester Park	6 acres	approved Dec. 14, 1891
Duluth Heights, Sixth Division	120 acres	approved Dec. 14, 1891
Willard and Piper's	80 acres	approved Dec. 14, 1891
Total area of plats	637 acres.	

These plats have all been approved by the Common Council and recorded with the Register of Deeds for St. Louis county, with the exception of the plat of Windermere Division, which has not yet been recorded.

Plats of rearrangements have been examined and approved as follows:

Fleischer & Cremer's Rearrangement, Block 56, Third Division.
Walbank's Rearrangement, Third street.
Summit Park Rearrangement.
Langelier's Rearrangement, Block "D," Endion Division.
Warner's Rearrangement, Block 141, Third Division.

STREET SPRINKLING.

The street sprinkling the past year was divided into districts, which were as follows:

District No. 1—First street, from Twelfth avenue east to Ohio avenue; Bench street, from Eighth avenue east to Missouri avenue; Superior street, from Eighth avenue east to Twelfth avenue east.

District No. 2—Superior street, from Eighth avenue west to Eighth avenue east.

District No. 3—First street, from Eighteenth avenue west to Twelfth avenue east.

District No. 4—Michigan street, from Fifth avenue west to Second avenue east; First avenue east, Lake avenue, First avenue west, Second avenue west, Third avenue west and Fourth avenue west, from Michigan street to First street; Fifth avenue west from Superior street south to within 200 feet of the dock line.

District No. 5—Michigan street, from Fifth avenue west to Ninth avenue west and from Thirteenth avenue west to Twenty-fourth avenue west; Piedmont avenue from Eighth avenue west to Thirteenth avenue west.

District No. 6—Piedmont avenue, from Thirteenth avenue west to Fourteenth avenue west; Superior street, from Fourteenth avenue west to Twenty-eighth avenue west.

Each district was let separate. The total length of all the districts was 9.75 miles and the total cost was $520.31 per mile. The coming year there will be more sprinkling than ever, made necessary by the paving of Second street from Sixth avenue west to Thirteenth avenue east and Garfield avenue from Michigan street fo the established dock line. On account of this additional amount of territory required to be sprinkled the Board have purchased two more sprinklers of the Miller–Knoblock Wagon Company, of South Bend, Ind.

OFFICE WORK.

On account of the large amount of work done the past year, and the making of special assessments to pay for same, it was found necessary to employ one clerk all the time and one other clerk two or three months, who did nothing else but work on the assessments. The assessments, as far as can be, have all been made, with exception of Piedmont avenue east, which we are working on at present.

Details of the principal items of this work for the year are shown in the following table:

Permits given to occupy streets for storage of building material and other purposes	122
Permits to move buildings on streets	22
Notices to repair walks, clean streets, remove rubbish, etc	35
Notices to police department in relation to encroachments, obstructions, etc., in streets	21
Reports made to Common Council upon matters referred to the Board	34
Estimates referred to the Common Council	230
Miscellaneous communications to the Common Council	173
Proposed improvements referred to the City Engineer for investigation and report	53
Plats referred to City Engineer	22
Miscellaneous orders and notices to the City Engineer	266
Assessment rolls made	60
Duplicates of same for Comptroller	60
Sidewalk assessments made for the Common Council	21
Unclassified official letters and notices	586
Total number of official letters written during the year	1,049
Official notices for publication	211
Whole number insertions given official notices	1,267
Permits to excavate in highways	11
The whole number of meetings held by the Board during the year was	132

In Exhibit "I" is given a summary of the extent of public improvements and their cost to date so far as given by data available.

In conclusion I have to acknowledge the receipt of public documents from Senator C. K. Davis, the Superintendent of the United States Coast and Geodetic Survey, the Superintendent of Census; also valuable reports and documents relative to municipal offices connected with the government of the following cities: St. Paul, Minneapolis, Milwaukee, Wis., Washington, D. C., and other cities.

Respectfully submitted,

THURLOW W. ABELL,
Clerk of the Board of Public Works.

EXHIBIT "A."

Contracts for Street, Avenue and Alley Improvements.

EXHIBIT "A."

Contracts for Street, Avenue and Alley Improvement.

Contract No.	Date.	Contractors.	Improvement.	Location.	From	To	Contract Price Based on Engineer's Estimate.	Amount of Bond.	Names of Sureties.
158	March 7, 1891	Robt. F. Wilson	Paving	Second street	Sixth Ave West	Thirteenth Ave East	$ 93,614 00	$31,000 00	Arthur B. Chapin, J. W. Norton, David B. Thatcher.
159	April 1, 1891.	Thomas & Sheridan	Grading	Second street	Thirteenth Ave East	Kentucky Ave	60,780 10	23,000 00	John J. Costello and J. W. Anderson.
160	April 2, 1891.	A. & D. Sang	Grading	Twenty-fifth Ave West	Michigan street	Eighth street	10,574 12	3,200 00	Henry C. Nelson and Morris Thomas.
161	April 3, 1891.	Carlson, Traff & Co.	Grading	Ninth Ave East	Bench street	Eleventh street	20,094 43	16,000 00	Emmanuel G. Swanstrom and Nils Hall.
163	April 4, 1891.	Davis & Cooper	Grading	Second street	Seventeenth Ave West	Grand Forks Ave	48,469 70	22,500 00	R. S. Munger, A. B. Chapin and Shubael F. White.
164	April 4, 1891.	Davis & Cooper	Grading	Jefferson street	Thirteenth Ave East	Montana Ave	19,007 50	21,000 00	R. S. Munger, A. B. Chapin and Shubael F. White.
...	...	...	...	Oregon Ave	Lake Superior	Fourth street	18,009 50		
165	April 4, 1891.	Davis & Cooper	Grading	Pennsylvania Ave	South street	Fourth street	10,293 20	8,500 00	R. S. Munger and A. B. Chapin.
168	April 20, 1891	Thomas Reilly	Paving	Garfield Ave	Michigan street	Established dock line	59,607 32	20,000 00	J. P. Gribben, A. C. Bruce and R. S. Munger.
171	April 29, 1891	Zimmerman, Truax & Co.	Paving	Fifth Ave West	Superior street	Third street	11,513 78	3,200 00	W. P. Heimbach and J. B. Sutphin.
173	April 30, 1891	E. J. Amory	Grading	Piedmont Ave East	Eighth Ave West	North line of Third Div.	78,103 00	26,000 00	J. J. Costello, R. A. Costello and Moris Thomas.
178	June 4, 1891.	L. Meining & Co.	Grading	Superior street	Virginia Ave	South line of Sec. 7-50-13.	57,003 82	16,000 00	Michael Norris and B. Silberstein.
179	June 4, 1891.	Hogan & Campbell	Grading	Ohio Ave	Lake Superior	Eighth street	17,941 09	7,000 00	Michael Norris and Simon Clark.
187	June 26, 1891	W. C. Doherty	Grading	Bench street	Montana Ave	North line of East Duluth	33,721 10	12,000 00	R. S. Munger W. W. Spalding
189	July 6, 1891.	Zimmerman & Bunnell	Grading	Twenty-third Ave West.	Michigan street	Piedmont Ave	22,094 90	20,000 00	J. J. Costello and Herman E. Long.
192	July 30, 1891.	Meniece & Norris	Grading	Superior street	Twenty-eighth Ave West	South city limits	26,438 02	7,000 00	Louis Rouchleau and Wm. Barnett.
193	Aug. 13, 1891.	Mike Fitzgerald	Grading	Third alley	Fourth Ave East	Sixth Ave East	887 29	300 00	Shubael F. White and W. W. Sanford.
199	Sept. 15, 1891	A. & D. Sang	Grading	Second alley	Eighteenth Ave West	Twenty-eighth Ave West	14,671 00	5,000 00	Leonidas Merritt and R. A. Costello.
201	Oct. 16, 1891.	John A. McLean & Co.	Grading	Third alley	Twenty-eighth Ave West	West city limits	3,640 40	1,200 00	Roger S. Munger and Albert Poirier.
205	Dec. 21, 1891.	Fredin & Wilson	Paving	Lake Ave	Superior street	Ship canal	54,845 00	23,000 00	Milo Hall, J. J. Costello, J. A. Waterworth, H. Fee and John A. Carlson.
					Total		$661,309 27		

EXHIBIT "B."

Contracts for Storm Water Sewers.

EXHIBIT "B."

Contracts for Storm Water Sewers.

Contract No.	Date.	Contractors.	Material.	Location.	From	To	Contract Price Based on Engineer's Estimates.	Amount of Bond.	Names of Sureties.	Remarks.
160	April 2, 1891.	A & D. Sang	Brick and Pipe	Twenty-fifth Ave West	Michigan street	Eighth street	$ 4,388 50			For Bond see Contract No. 160, Exhibit "A."
161	April 3, 1891.	Carlson, Traff & Co.	Brick and Pipe	Ninth Ave East	Bench street	Tenth street	18,924 75			For Bond see Contract No. 161, Exhibit "A."
163	April 4, 1891.	Davis & Cooper	Brick and Pipe	Second street	Seventeenth Ave West	Twenty second Ave West	8,800 00			For Bond see Contract No. 163, Exhibit "A."
				Twenty-second Ave West	Michigan street	Second street	3,800 00			
164	April 4, 1891.	Davis & Cooper	Brick and Pipe.	Oregon Ave	Lake Superior	Fourth street	18,304 00			For Bond see Contract No. 164. Exhibit "A "
165	April 4, 1891.	Davis & Cooper	Brick and Stone	Pennsylvania Ave	Lake Superior	Fourth street	15,300 00			For Bond see Contract No. 165, Exhibit "A."
179	June 4, 1891.	Hogan & Campbell	Pipe and Concrete	Ohio Ave	Lake Superior	Seventh street	7,534 00			For Bond see Contract No. 179, Exhibit "A."
191	July 24, 1891.	E. J. Amory	Brick and Pipe	Lake Ave	Fifth street	Piedmont Ave East	4,890 00	$ 1,700 00	J. J. Costello & Benj. Hogan	
189	July 6, 1891.	Zimmerman & Bunnell	Brick and Pipe	Twenty-third Ave West	Park Ave	Third street	35,291 00			For Bond see Contract No. 189, Exhibit "A."
				Third street	Twenty-third Ave West	Twenty-second Ave West				
205	Dec. 21, 1891.	Fredin & Wilson	Pipe	Lake Ave	Michigan street	Ship Canal	13,501 50			For Bond see Contract No. 205, Exhibit "A."
					Total		$130,733 75			

EXHIBIT "C."

Contracts for Sanitary Sewers.

EXHIBIT "C."

Contracts for Sanitary Sewers.

Contract No.	Date.	Contractors.	Material.	Location.	From	To	Contract Price Based on Engineer's Estimate.	Amount of Bond.	Names of Sureties.	Remarks.
159	April 1, 1891.	Thomas & Sheridan.....	Pipe..............	Second street..............	Fourteenth Ave East........	Ohio Ave	$ 5,642 80	....	....	For Bond see Contract No. 159, Exhibit "A."
...	....	....	....	Fourteenth Ave East......	First street...	Second street.................	1,201 40	....	....	
162	April 3, 1891.	Carlson, Traff & Co	Pipe..............	Fifth alley.........	Lake Ave.........	Fifth Ave West...............	3,966 10	$ 1,300 00	Emanuel G. Swanstrom and Nils Hall.	
163	April 4, 1891.	Davis & Cooper...........	Pipe	Second street................	Seventeenth Ave West......	Grand Forks Ave............	6,500 00	....	....	For Bond see Contract No. 163, Exhibit "A."
166	April 8, 1891.	Zimmerman, Truax & Co	Brick and Pipe...	Second alley.............. .	Piedmont Ave West..........	Twenty-eighth Ave West....	15,188 06	3,000 00	John J. Costello and A. Michaud.	
167	April 14, 1891	Walter C. Doherty.......	Pipe	Fifth street...................	200 ft west Second Ave East	Sixth Ave East..	3,623 40	1,300 00	E. R. Jefferson and R. S. Munger.	
169	April 23, 1891	L. Meining & Co....... ..	Pipe	First street....................	Thirteenth Ave East.........	Fourteenth Ave East........	834 00	300 00	Michael Norris and Geo. Wm. Goldsmith.	
172	April 27, 1891	J. D. O'Connell	Pipe..............	Seventh Ave West...........	Second street......	Third street..................	488 00	175 00	E. L. Toomey and Manus Brown.	
174	May 5, 1891..	Joseph Wolf..............	Brick and Pipe...	First street....................	Seventeenth Ave West.....	Twenty-second Ave West...	10,966 50	4.000 00	Morris Thomas and A. B. Chapin.	
188	June 29, 1891	C. M. Johnson...........	Pipe..............	Third street...................	Fourteenth Ave East........	Pennsylvania Ave...........	2,639 50	1,000 00	Anton Larson, J. L. Pember and C. E. Evans.	
195	Aug. 27, 1891	John F. Myhrberg & Co.	Pipe..............	Centre street..................	Ohio Ave....................	Indiana Ave..................	760 90	300 00	Andrew G. Olson and Erick N. Olson.	
196	Sept. 24, 1891	C. M. Johnson...........	Pipe..............	Second alley........	Fourteenth Ave East........	New York Ave...............	525 06	200 00	Anton Larson and Anton Ringsred.	
197	Sept. 24, 1891	Mitchell & Watson.......	Pipe..............	First alley......................	Ohio Ave.....................	Oregon Ave.........	2,247 50	775 00	John T. Culbertson.	
200	Oct. 14, 1891.	E. J. Amory.............	Pipe..............	Sixth alley.....................	Third Ave East..............	Fourth Ave East............	1,294 75	450 00	D. S. McKay and W. V. Robson.	
204	Nov. 10, 1891	John F. Myhrberg & Co.	Pipe..............	First alley	Fourteenth Ave East........	New York Ave......	652 50	250 00	Andrew G. Olson and Erick W. Olson.	
					Total.	....	$ 56,530 47			

EXHIBIT "D."

Contracts for Sidewalks.

EXHIBIT "D."

Contracts for Sidewalks.

Contract No.	Date.	Contractors.	Material.	Side of Street.	Street or Avenue.	From	To	When Ordered by Council.	Width of Walk in Feet.	Contract Price per Lineal Foot.	ASSESSMENTS.		Remarks.
											When Sent to Council.	Amount.	
A28	May 9. 1891	John Boyer	Plank	...	Railroad street	Fifth avenue west	Sixth avenue West	April 29, 1891	8	$ .35	...	...	No assessment, cost $197.35.
A29	June 5, 1891	Edward Low	Plank	West	Twelfth avenue East	Fourth street	Fifth street	April 29, 1891	3	.13½	July 6, 1891	$ 44 55	
A30	June27,1891	J W. Preston	Plank	West	Twenty-eighth avenue West	Superior street	Railroad alley	April 27, 1891	3	.12	July 17, 1891	106 25	
A31	June27,1891	J. W. Preston	Plank	South	Seventh street	Fourth avenue East	Fifth avenue East	April 20, 1891	5	.38	Aug. 17, 1891	26 12	
A32	July 24,1891	Edward Low	Plank	North South	Piedmont avenue West	Superior street	Seventh street Twenty-fourth ave West	May 11, 1891	8	.32½ .41	Oct. 12, 1891	2,865 15	
A33	July 24,1891	Bdward Low	Plank	North	Fifth street	Twenty-third avenue West	Twenty-fourth avenue West	May 4, 1891	3	.22	Aug. 17, 1891	64 49	
A34	July 24,1891	Edward Low	Plank	North	Fifth street	Fifth avenue West	Sixth avenue West	June 8, 1891	8	.45	Aug 17, 1891	108 11	
A35	July 24,1891	Edward Low	Plank	West	Twelfth avenue East	Fifth street	Sixth street	June 8, 1891	6	.28	Aug. 17, 1891	99 02	
A36	July 24,1891	Edward Low	Plank	East	Fifth avenue West	Michigan street	St. P. & D. R. R. tracks	May 4, 1891	10	.45	Sept. 21, 1891	95 18	
A37	July 27,1891	Jens Salem	Plank	East West	Twenty-fifth avenue West	Michigan street	Eighth street	May 25, 1891	8	.31½	Nov. 2, 1891	1,392 55	
A38	Aug.13,1891	Jens Salem	Plank	North	Piedmont avenue West	Seventh street	Ninth street	May 25, 1891	8	.32	Oct. 26, 1891	318 14	
A39	Aug.13,1891	Jens Salem	Plank	North	First street	Tenth avenue West	Twelfth avenue West	June 22, 1891	8	.34	Oct. 19, 1891	308 20	
A40	Aug.13,1891	Anderson & Landfold	Plank	West	New York avenue	Superior street	Fourth street	June 22, 1891	8	.31½	Oct. 10, 1891	488 69	
A41	Aug.13,1891	Anderson & Landfold	Plank	North	Superior street	Second avenue East	Eighth avenue East	June 22, 1891	12	.48	Sept. 21, 1891	1,171 35	
A42	Aug.27,1891	Edward Low	Plank	West	Twenty-second avenue West	Third street	Fourth street	July 6, 1891	3	.119	Sept. 21, 1891	37 37	
A43	Aug.27,1891	Edward Low	Plank	South	Superior street	Twenty-seventh avenue West	Twenty-eighth avenue West	July 6, 1891	8	.33	Oct. 19, 1891	139 79	
A44	Aug 27,1891	John Mattson	Plank	East West	Garfield avenue Garfield avenue	Michigan street Michigan street	100 ft. S. of S. line Oak ave Dock line	July 6, 1891	10	.3973	Nov. 16, 1891	2,954 34	
A45	Aug.31,1891	J.W.Preston	Plank	South	Bench street	Montana avenue	Oregon avenue	July 1, 1891	8	.33	Sept. 21, 1891	137 94	
A46	Sept.29,1891	Arnt Anderson	Plank	North	Third street	Fourth avenue East	Sixth avenue East	Aug. 10, 1891	8	.34	Nov. 2, 1891	272 78	
A47	Sept.29,1891	J.W. Preston	Plank	North	First street	Sixth avenue West	Seventh avenue West	Aug. 10, 1891	8	.33	Nov. 30, 1891	132 79	
A48	Sept.29,1891	Edward Low	Plank	North	Third street	Lake avenue	First street	Aug. 10, 1891	8	.34½	Oct. 19, 1891	121 13	Excepting 50 feet previously built.
A49	Sept.29,1891	Arnt Anderson	Plank	North	Third street	Second avenue East	Third avenue East	Aug. 10, 1891	8	.34	Nov. 2, 1891	136 51	
A50	Oct. 14, 1891	Edward Low	Plank	South North	Jefferson street Jefferson street	Thirteenth avenue East Thirteenth avenue East	Ohio avenue Oregon avenue	Aug. 17, 1891 ...	8 ...	.33 ...	... ...	... ...	Walk unfinished.
A51	Oct.29, 1891	Bartlett & Olson	Plank	East West	Ohio avenue	Southerly end Ohio avenue	Eighth street	Sept. 14, 1891	6	.27	...	...	
A52	Oct.29, 1891	Bartlett & Olson	Plank	East	Oregon avenue	Southerly end Oregon ave	Fourth street	Sept. 14, 1891	6	.27	...	...	Walk unfinished.
A53	Oct.27, 1891	Sullivan & Hackett	Plank	West	Pennsylvania avenue	Fourth street	London Road	Sept. 21, 1891	8	.31½	...	...	Walk unfinished.
A54	Nov.16,1891	Edward Low	Plank	Both	Second street	Piedmont avenue West	Grand Forks avenue	Sept. 28, 1891	8	.33	Dec. 28, 1891	596 68	
A55	Nov.10,1891	John Boyer	Plank	West	Garfield avenue	125 ft north of Ash avenue	Oak avenue	Sept. 28, 1891	10	.4095	...	...	Walk unfinished.
A56	Nov.30,1891	John Boyer	Plank	West	Garfield avenue	Michigan street	St. P. & D. R. R. tracks	Oct. 5, 1891	16	7274	Jan. 11, 1892	1,086 96	
A57	...	N. Young	Plank	Both	Ninth avenue East	Bench street	Eleventh street	Oct. 12, 1891	8	.28½	Jan. 2, 1892	231 48	
A58	Jan. 4, 1892	J. W. Preston	Plank	West	Thirteenth avenue East	Second street	Fourth street	Oct. 19, 1891	4	.16	...	...	Cancelled.
A59	Jan. 4, 1892	E. J. Amory	Plank	East	Fourth avenue West	Fourth street	Piedmont avenue East	Oct. 19, 1891	6	.29	Jan. 2, 1892	96 45	
A60	Jan. 4, 1892	J. W. Preston	Plank	South North	Piedmont avenue Piedmont avenue	Third avenue West Fourth avenue West	Fourth ave West Fifth street	Oct. 19, 1891	8	.33	...	...	Walk unfinished. Walk unfinished.
A18	Oct.13, 1890	Colby Smith	Plank	North South	Superior street Superior street	Eighth avenue East Tenth avenue East	Ohio avenue Virginia avenue	Aug. 28, 1890	8	.32½	...	2,776 28	This contract was let previous to our fourth annual report, but not completed until afterward.
							Total amount assessed	...	...	...	...	$ 15,805 30	

EXHIBIT "E."

Miscellaneous Contracts.

EXHIBIT "E."

Miscellaneous Contracts.

Contract No.	Date.	Contractors.	Nature of Work.	Location.	Contract Price.	Amount of Bond.	Names of Sureties.	Remarks.
170	April 23, 1891	Seipel, Miller & Hunter	Printing annual report		$ 463 70	$ 200 00	G. A. French and Dwight E. Woodbridge.	
175	May 21, 1891	W. H. Holden	Wooden trestles	Railroad st, 7th ave w to 6th ave w	3,456 00	1,200 00	Barney Trimbo and Pat Ryan.	
176	May 26, 1891	James W. Preston	Cross walks	At street intersections where ordered	1,678 15	500 00	Chas. S. Pierce and Chas. A. Britts.	
177	May 21, 1891	Pauly Jail Bldg & Mfg Co	Jail cells	City jail.	449 00	150 00	William S. Woodbridge and A. B. Chapin.	
180	June 5, 1891	Charles Peterson	Sprinkling streets	District No. 5	717 17	500 00	Nils Hall and John P. Lundquist.	
181	June 5, 1891	Charles Peterson	Sprinkling streets	District No. 6	718 17	500 00	Nils Hall and John P. Lundquist.	
182	June 12, 1891	M. Haug & Bro.	Sprinkling streets	District No. 1	740 00	500 00	Ernest R. Jefferson and Jos. A. Mannheim.	
183	June 12, 1891	M. Haug & Bro	Sprinkling streets	District No. 2	853 33	500 00	Ernest R. Jefferson and Jos. A. Mannheim.	
184	June 12, 1891	M. Haug & Bro	Sprinkling streets	District No. 3	725 00	500 00	Ernest R. Jefferson and Jos. A. Mannheim.	
185	June 12, 1891	M. Haug & Bro.	Sprinkling streets	District No. 4	853 33	500 00	Ernest R. Jefferson and Jos. A. Mannheim.	
186	June 26, 1891	George Taylor.	Wooden trestles	Railroad st, 5th ave w to 6th ave w	3,760 50	1,400 00	C. Poirier and August Rehbein.	
194	Aug. 13, 1891	Hugh McGinnis	Erecting and maintaining oil lamps	Lake ave, Park Point		150 00	Laughlin McLean and John McDonald.	
202	Oct. 29, 1891	LaVaque Paint & Wall Paper Co	Painting wooden trestle	Railroad st, 7th ave w to 6th ave w	390 00	135 00		(Certified check.)
203	Oct. 31, 1891	W. H. Holden.	Timber approach	South end 6th ave w viaduct	3,189 80	1,100 00	Barney Trimbo and Pat Ryan	
				Total	$ 17,994 15			

EXHIBIT "F"

Assessments for Street, Avenue and Alley Improvement.

EXHIBIT "F."

Assessments for Street, Avenue and Alley Improvement.

Location.	From	To	FIRST ASSESSMENT.				FINAL ASSESSMENT.				Total Assessments.
			Made.	Confirmed and Filed.	Copy Filed with Comptroller.	Amount.	Made.	Confirmed and Filed.	Copy Filed with Comptroller.	Amount.	
Second street	Sixth avenue west	Thirteenth avenue east	June 25, 1891	July 11, 1891	July 14, 1891	$ 77,021 84					$ 77,021 84
Second street	Thirteenth avenue east	Kentucky avenue	June 25, 1891	July 11, 1891	July 14, 1891	51,616 85					51,616 85
Twenty-fifth avenue west	Michigan street	Eighth street	June 25, 1891	July 11, 1891	July 14, 1891	6,706 50					6,706 50
Ninth avenue east	Bench street	Eleventh street	June 25, 1891	July 11, 1891	July 14, 1891	22,842 92	Feb. 18, 1892	March 5, 1892	March 5, 1892	$ 145 18	22,988 10
Jefferson street	Thirteenth avenue east	Montana avenue	Aug. 10, 1891	Aug. 29, 1891	Sept. 1, 1891	16,049 48					16,049 48
Oregon avenue	Lake Superior	Fourth street	Aug. 10, 1891	Aug. 29, 1891	Sept. 1, 1891	17,534 78					17,534 78
Pennsylvania avenue	South street	Fourth street	June 25, 1891	July 11, 1891	July 14, 1891	12,557 41					12,557 41
Garfield avenue	Michigan street	Established dock line	Aug. 10, 1891	Aug. 29, 1891	Sept. 1, 1891	33,436 67					33,436 67
Fifth avenue west	Superior street	Third street					Sept. 9, 1891	Sept. 26, 1891	Sept. 28, 1891	12,665 16	12,665 16
Bench street	Montana avenue	North line of East Duluth	Sept. 9, 1891	Sept. 26, 1891	Sept. 28, 1891	31,119 82					31,119 82
Twenty-third avenue west	Michigan street	Piedmont avenne	Oct. 12, 1891	Oct. 31, 1891	Nov. 2, 1891	23,822 18					23,882 18
Superior street	Twenty-eighth avenue west	South city limits	Sept. 9, 1891	Sept. 26, 1891	Sept. 28, 1891	15,734 11					15,734 11
Third alley	Fourth avenue east	Sixth avenue east					Dec. 28, 1891	Jan. 9, 1892	Jan. 11, 1892	976 02	976 02
Bench street	Eighth avenue east	Montana avenue					Oct. 12, 1891	Oct. 31, 1891	Nov. 2, 1891	25,801 66	25,801 66
Second alley	Ninth avenue east	West bank of Chester creek					Dec. 24, 1891	Jan. 9, 1892	Jan. 11, 1892	6,226 24	6,226 24
Michigan street	Twenty-fourth avenue west	South city limits					June 25, 1891	July 11, 1891	July 14, 1891	8,470 21	8,470 21
Fourth alley	Fifth avenue east	Seventh avenue east					Oct. 12, 1891	Oct. 31, 1891	Nov. 2, 1891	2,667 68	2,667 68
Fourth street	Fifth avenue west	Sixth avenue east	Oct. 9, 1890	July 11, 1891	July 14, 1891	37,899 84	Dec. 19, 1891	Jan. 9, 1892	Jan. 11, 1892	11,083 28	48,983 12
Piedmont avenue west	Superior street	West city limits	June 29, 1891	July 18, 1891	July 21, 1891	33,032 19					33,032 19
						Grand total					$447,470 02

EXHIBIT "G."

Assessments for Storm Water Sewers.

EXHIBIT "G."

Assessments for Storm Water Sewers.

Location.	From	To	FIRST ASSESSMENT.				FINAL ASSESSMENT.				Total Assessments
			Made	Confirmed and Filed.	Copy Filed with Comptroller.	Amount.	Made	Confirmed and Filed	Copy Filed with Comptroller.	Amount.	
Twenty-fifth avenue west	Michigan street	Eighth street	June 25, 1891	July 11, 1891	July 14, 1891	$3,522 85	Feb. 18, 1892	Mar. 5, 1892	Mar. 5, 1892	$5,355 10	$ 8,877 95
Ninth avenue east	Bench street	Tenth street	June 25, 1891	July 11, 1891	July 14, 1891	14,782 50					14,782 50
Oregon avenue	Lake Superior	Fourth street	Aug. 10, 1891	Aug. 29, 1891	Sept. 1, 1891	18,304 00					18,304 00
Pennsylvania avenue	Lake Superior	Fourth street	June 25, 1891	July 11, 1891	July 14, 1891	8,557 20					8,557 20
Lake avenue	Fifth street	Piedmont avenue east					Feb. 18, 1892	Mar. 5, 1892	Mar. 5, 1892	6,867 48	6,867 48
							Grand total				$57,389 13

EXHIBIT "H."

Assessments for Sanitary Sewers.

EXHIBIT "H."

Assessments for Sanitary Sewers.

Location.	From	To	FIRST ASSESSMENT.				SECOND ASSESSMENT.				Total Assessments
			Made	Confirmed and Filed.	Copy Filed with Comptroller	Amount.	Made	Confirmed and Filed.	Copy Filed with Comptroller	Amount.	
Second street	Fourteenth avenue east	Ohio avenue	June 25, 1891	July 11, 1891	July 14, 1891	$3,059 52					$ 3,059 52
Fourteenth avenue east	First street	Second street	June 25, 1891	July 11, 1891	July 14, 1891	1,040 64					1,040 64
Superior street	Fourteenth avenue west	Nineteenth avenue west					June 25, 1891	July 11, 1891	July 14, 1891	$3,329 47	3,329 47
Fourth alley	Fifth avenue east	Tenth avenue east					July 9, 1891	Aug. 29, 1891	Sept. 1, 1891	6,660 72	6,660 72
Sixth avenue west and Piedmont avenue east	Superior street	Fourth street					Sept. 9, 1891	Sept. 26, 1891	Sept. 28, 1891	3,909 81	3,909 81
Fifth alley	Lake avenue	Fifth avenue west					Oct. 12, 1891	Oct. 31, 1891	Nov. 2, 1891	5,811 47	5,811 47
Jefferson street	Fourteenth avenue east	Ohio avenue					Oct. 12, 1891	Oct. 31, 1891	Nov. 2, 1891	6,032 08	6,032 08
Second alley	Piedmont avenue west	Twenty-eighth avenue west					Jan. 18, 1892	Jan. 30, 1892	Feb. 8, 1892	22,406 05	22,406 05
Fifth street	200 ft west of Second ave east	Sixth avenue east					Nov. 27, 1891	Dec. 12, 1891	Dec 14, 1891	3,688 10	3.688 10
First street	Thirteenth avenue east	Fourteenth avenue east					July 6, 1891	Aug. 29, 1891	Sept. 1, 1891	1,155 99	1,155 99
Seventh avenue west	Second street	Third street					June 25, 1891	July 11, 1891	July 14, 1891	458 92	458 92
First street	Seventeenth avenue west	Twenty-second avenue west					Dec. 19, 1891	Jan. 9, 1892	Jan. 11, 1892	10,832 04	10,832 04
Third street	Fourteenth avenue east	Pennsylvania avenue					Jan. 18, 1892	Jan. 30, 1892	Feb. 3, 1892	2 756 60	2,756 60
First street	Missouri avenue	Montana avenue					Dec. 24, 1891	Jan. 9, 1892	Jan. 11, 1892	1,568 97	1,568 97
Centre street	Ohio avenue	Indiana avenue					Dec. 24, 1891	Jan. 9, 1892	Jan. 11, 1892	641 81	641 81
Second alley	Fourteenth avenue east	New York avenue					Dec. 24, 1891	Jan. 9, 1892	Jan. 11, 1892	568 19	568 19
First alley	Fourteenth avenue east	New York avenue					Dec. 28, 1891	Jan. 9, 1892	Jan. 11, 1892	709 09	709 09
Second alley	Ninth avenue east	West bank of Chester creek					Dec. 24, 1891	Jan. 9, 1892	Jan. 11, 1892	2,044 46	2,044 46
Superior street	Fourteenth avenue east	Ohio avenue					Jan. 18, 1892	Jan. 30, 1892	Feb. 3, 1892	2,801 96	2,801 96
							Grand total				$79,475 89

EXHIBIT "I."

Showing Extent and Cost of Public Improvements to Date.

YEAR.	MILES CONSTRUCTED.					AMOUNT EXPENDED.						
	Grading Streets and Alleys.	Paving.	Storm Sewers.	Foul Water Sewers.	Sidewalks.	Grading	Paving.	Storm Sewers.	Foul Water Sewers.	Bridges.	Sidewalks.	Miscellaneous.
Previous to 1887 ..	23.1	......	.....	1.61	14.15	$ 225,622 84	....	....	$ 32,752 83	$ 385 00	$ 5,827 36	....
1887..........	13.7	......	......	6.34	9.71	115,816 73	....	....	139,742 76	....	13,978 01	....
1888..........	10.5	1.5	3.04	4.26	9.50	473,433 68	$123,210 16	$ 93,319 94	55,124 75	....	20,128 76	$ 1,412 65
1889....	7.7	1.4	2.94	3.66	15.34	329,479 15	45,656 70	62,115 53	65,373 39	16,150 00	33,246 50	1,545 39
1890...............	5.6	3.4	2.04	3.18	12.82	54,322 57	251,066 05	53,906 96	39,732 55	....	24,332 07	....
1891...............	14.6	7.4	3.40	4.66	10.62	319,195 19	343,788 22	119,195 43	80,728 06	10,293 27	20,952 83	....
Totals......	75.2	13.7	11.42	23.71	72.14	$1,517,870 16	$763,721 13	$328,537 86	$413,454 34	26,828 27	$118,465 53	$ 2,958 04

ANNUAL REPORT

—OF THE—

CITY ENGINEER

For Year Ending February 29, 1892.

City Engineer's Report

FOR THE YEAR ENDING FEBRUARY 29, 1892.

CITY ENGINEER'S OFFICE,
April 27, 1892.

To the Board of Public Works:

GENTLEMEN:—Complying with your order of the 19th inst., and in conformity with the usual custom, I beg to submit the following report on the operations of this department during the past year.

In addition to continuing the usual surveys for defining the street lines and setting the necessary reference points and monuments, one of the field parties was specially detailed during the winter to traverse the lake shore from the canal to the eastern city limits, so that it could be accurately platted and recorded on the city plans. When this was completed the same party was engaged in locating the county roads which were formerly under the control of the county authorities but which are now under the management of this department. Surveys were also made in connection with the proposed new water supply. The work of continuing preliminary levels in unimproved districts and streets has also been carried on, as far as circumstances would permit; and in addition thereto special attention has been devoted to establishing permanent bench marks on streets where these important points of reference did not previously exist. When this is completed it is expected to result in considerable saving of time by the field parties in staking out new works, as well as reducing the liability to error to a minimum.

There were ninety-nine contracts in operation during the year, involving, throughout the working season, a maximum outside engineering force of one assistant in general charge of construction, with eight subordinate engineers, each having a separate party composed of one transit man and two rod men.

The maximum number of inspectors employed at any one time was twenty-nine.

The office force during the busiest time consisted of one assistant in general charge, two draughtsmen, four calculators, one cement tester and inspector of private drains, one accountant and one stenographer, the latter being engaged jointly with the Board of Public Works.

A separate office was established at the west end of the city for the convenience of the parties in that locality, not only on account of there being insufficient room for them all at the main office, but also to economize time.

The amount paid for engineering services during the year was $30,199.51 and the total cost of the engineering department proper was $32,815.86 or 3 57-100 per cent on the actual expenditures for work performed, not taking into account surveys and investigations for street lines, proposed improvements, etc.

The maintenance of streets and sewers (exclusive of street sprinkling, which was done by contract) cost $33,806.53 and other services as enumerated below cost $17,014.36, making the total disbursements during the year, including amounts certified as due to contractors, $954,366.74.

The following statements contain in a concise form the expenditures on engineering and maintenance during the year as well as the comparative expenditures on contracts and the cost of engineering and inspection for the past three years:

STATEMENT OF COST OF ENGINEERING AND MAINTENANCE DEPARTMENTS.

Engineering labor	$ 30,199 51	
Engineering material	2,616 35	
		$ 32,815 86
Inspecting contracts		9,982 07
Street and sewer labor	$ 39,798 29	
Street and sewer material	8,560 58	
		48,358 87

Road roller labor	$ 1,659 40		
" " material and repairs	1,036 49		
		2,695 89	
Total cash expenditure of Department			$ 93,852 69
Less credits, as below			10,215 94
Actual cost of Engineering and Maintenance Departments			$ 83,636 75

SUMMARIZED STATEMENT.

General office	$ 9,304 78		
Preliminary surveys	741 12		
Permanent	1,189 67		
Estimating new work	693 93		
Condemnations	127 69		
New divisions	503 68		
Lines and grades for outside parties	21 62		
Engineering contracts	19,286 77		
Water works investigation	946 60		
		$ 32,815 86	
Inspection		9,982 07	
Maintenance of streets	$ 27,045 23		
" " sewers	6,761 30		
		33,806 53	
Completing contracts (by Maintenance Department)		3,947 29	
New work (by Maintenance Department)		2,322 42	
Special work (by Maintenance Department)		4,474 73	
Work for outside parties		3,807 90	
Road roller (expense of running)		2,695 89	
Total cash expenditures of Department			$ 93,852 69
Less Credits—			
Work done by road roller	$ 2,460 75		
Work done for individuals	3,807 90		
Amount charged back to contractors	3,947 29		
			10,215 94
Actual cost of the Department, including maintenance of streets and sewers			$ 83,636 75

Comparative statement showing amount of contract work done by the city for the years 1889, 1890 and 1891:

	1889.	1890.	1891.
Streets	$391,285 85	$305,388 62	$652,310 07
Sanitarysewers	65,373 39	39,732 55	80,728 06
Storm sewers	62.115 53	53,906 97	119,195 43
Sidewalks	33,246 50	18,778 67	18,496 43
Total	$552,021 27	$417,806 81	$870,729 99
Cost of staking and estimating work	$ 11,229 51	$ 9.5 9 24	$ 19,286 77
Cost of inspecting work	7,198 99	9,982 21	9,982 07
Percentage cost of engineering	2.01%	2.31%	2.18%
Percentage cost of inspecting	1.30%	2.39%	1.13%

During the year there were twenty-five petitions or orders for new improvements investigated and reported upon as against 101 last year. The approximate estimates of the cost of said improvements were as follows:

	1890–91.	1891–92.
Grading	$ 748,237 75	$ 11,613 91
Paving	453,806 45	325,326 25
Sewers	192,492 20	33.597 20
Sidewalks	20.735 03	....
Total	$1,415,271 43	$ 370,537 36
Cost of engineering on same	4,781 91	693 93
Percentage cost of engineering	34-100 of 1%	19-100 of 1%
Estimate on water works (new supply)		$1,100,000 00
Gas and water (duplicate present system)		1,091,107 00
New work before estimated		370,537 36
Total amount of work estimated during 1891		$2,561,644 36
Cost of engineering on same		$ 951 76
Percentage cost of engineering		1-27 of 1%

The principal work performed consisted of 14 6-10 miles of streets graded and improved; 113,966 square yards of block pavement, and 49,102 sq. yards of Telford macadam laid; 4 7-10 miles of sanitary sewers constructed; 3 4-10 miles of storm sewers, and 10 6-10 miles of sidewalks built—not including the pavements laid by private individuals to replace temporary walks within the districts prescribed by ordinance.

The usual tables giving full particulars of the above works are appended to this report, and are as follows:

Table No. 1 relates to bridge and street improvement contracts.
Table No. 2 relates to sanitary sewer contracts.
Table No. 3 relates to storm sewer contracts.
Table No. 4 gives details respecting the sanitary sewers constructed.
Table No. 5 gives details respecting the storm sewers constructed.
Table No. 6 relates to sidewalk contracts.

Four additional tables (No. 7, 8, 9 and 10) are also appended, as they will be found of utility for future reference.

Table No. 7 is a complete list of all monuments set to date.
Table No. 8 is a complete list of all sanitary sewers built to date.
Table No. 9 is a complete list of all storm water sewers built to date.
Table No. 10 is a complete list of all combined sewers built to date.

The purchase of a road scraper and a rock crusher for the exclusive use of the city it is thought will effect economical results in the maintenance department.

The change made in the organization of the department by which the subordinate engineers in charge of parties are required to oversee the works upon which they are engaged and are held responsible for their proper performance, is a common system elsewhere. The engineers naturally take a greater interest in their work than when engaged simply at staking out, and the contracts get better and more thorough supervision without incurring any additional expenditure.

SUGGESTIONS AND RECOMMENDATIONS.

Several recommendations made in previous annual reports by the former engineer, Mr. Fuller, appear to me to deserve more consideration than they have so far received.

I would renew the recommendation for the acquisition by the city of a suitable storage or supply yard in some central locality, and would suggest that a similar storage yard would be advantageous in the West End also. As time advances the necessity for such storage grounds, with ample and convenient shed room, will become more and more apparent.

The recommendation that portions of the avenues above and below Superior street be paved from Second avenue east to Fourth avenue west, is also deserving of attention and should be carried out at least between Michigan and First streets.

During the past winter very little attention was paid by private parties to the ordinance relating to keeping the sidewalks clear of snow and ice. It is to be hoped that some more stringent rules regarding this matter will be enforced next winter.

The difficulty of compelling property owners to connect their private drains with the public sewers at the proper time and in the proper manner is not peculiar to this city. As I understand this matter, this department has no power to provide for laying private drains across the roadways when a new sewer is ordered in, unless specially called for in the petition. I would therefore suggest, in the public interests, that in future no petition be entertained which does not contain this provision, and that wherever such connections are deemed necessary or advisable they shall be included in the original contract for the work, as has already been done in some cases. There seems no occasion, however, under existing circumstances, to carry the private drain beyond the rear line of curb, in the majority of cases. Another difficulty arises in ensuring perfect and substantial sanitary work beyond that line and up to and through the buildings accommodated. The existing plumbing ordinance is inadequate to meet the requirements, and I would further suggest that it be so amended and enlarged as to make it effective. It would also seem desirable to consider the advisability of placing the supervision of the latter class of work in the hands of the health department which would have the right to call upon this office for professional assistance and advice whenever necessary.

I would also make the following suggestions, viz: (*a*) That the present arrangement of constructing retaining walls as lateral supports for private properties be reconsidered, with the view of changing the system, if found practicable, so that the actual damages may be assessed and paid to the owners at the time of carrying out any local improvement, and that, if walls are found to be necessary and are not constructed by the owners, the city may proceed to do the work and charge the cost against the property. (*b*) That the advisability of the city purchasing all necessary supplies of cement, sewer pipes and bricks for contract works be carefully considered. Under the present system the best quality of materials cannot always be relied upon as having been purchased, while the city pays high prices and does not get the benefit of such discounts as are usually allowed on large orders. (*c*) That in accepting plats of new divisions and additions to the city, special attention be given to the desirability of reserving at frequent intervals ample spaces for public parks and squares. (*d*) That the extension of storm water sewers across the railway property at the foot of all avenues in the central portion of the city, wherever necessary, be carried out as soon as practicable. (*e*) That the placing of large quantities of gravel on the avenues and elsewhere does not appear to be either economical or advisable, except perhaps in some special cases and on country roads where suitable material can be had within a reasonable haul. Even the best gravel got in this vicinity is not of a particularly good quality for roadway purposes, and when not washed away either down the hills or into the sewers, soon grinds up into mud and dust. Crushed rock, if used to only half the thickness to which the gravel is generally applied, would be much more durable, less liable to be washed away or ground up, and in most cases no more expensive in first cost.

Appended hereto will be found a special report on the proposed new water supply. Also the report of Mr. Lewis, the engineer in charge of all office work, and the report of Mr. Reed, the engineer in charge of construction. These reports will be found worthy of perusal.

I also append diagrams showing the results of cement tests made during the year.

Respectfully submitted,
E. H. KEATING,
City Engineer.

ANNUAL REPORT

—OF THE—

Assistant City Engineer,

IN CHARGE OF OFFICE WORK.

Report of Assistant City Engineer,

IN CHARGE OF OFFICE WORK.

DULUTH, Minn., March 2, 1892.

E. H. KEATING, City Engineer:

DEAR SIR:—Following is my report of work performed in this office for the year ending February 29, 1892:

Plans and specifications have been prepared for the following number of contracts now in progress or completed, to-wit:

Street grading	16
Street paving	8
Sanitary sewers	15
Storm water sewers	7
Sidewalks	30
Miscellaneous	6
Total	82

Sets of four of each of the above have been prepared.

The total amount of work done upon the above contracts as shown in Table No. 1 was $870,729.99.

Approximate estimates have been made under order for the following works not yet commenced or let.

Grading	2	Estimated cost	$ 5,833 00
Paving	6	" "	317,325 25
Sewers	6	" "	15,886 00
Total	14		$339,044 25

Final estimates were made upon sixty-six contracts, amounting in all to $265,290.60.

The number of maps, plans, profiles, etc., on file in this office has increased from 1,516 in 1891 to 1,704 in 1892. These are classified as follows:

Condemnation	80
Profiles	23
Tracings	121
Miscellaneous	6
Total	230

The approximate number of blue process tracings made was 2,000, aggregating 270 yards.

Profiles were made from levels run upon 8.03 miles of streets, avenues and alleys.

The total length of cross-section work computed for quantities amounted to 18.07 miles.

Thirteen condemnation plats were made for easements of slopes along improved streets, as follows:

Second street, from Thirteenth avenue east to Sixth avenue west.

Second alley, from Eighteenth avenue west to Twenty-eighth avenue west.

Superior street, from Twenty-first avenue west to Grand Forks avenue.

Piedmont avenue east, from Superior street to north city limits.

Twenty-third avenue west, from Second street to Ninth street.

Pennsylvania avenue, from South street to Fourth street.

Ninth avenue east, from Superior street to Eleventh street.

Oregon avenue, from Lake Superior to Fourth street.

Second street, from Seventeenth avenue west to Grand Forks avenue.

Jefferson street, from Thirteenth avenue east to Montana avenue.

Second alley, from Ninth avenue east to Thirteenth avenue east.

Third street, from Twenty-eighth avenue west to west city limits.

Fifth alley, from Eighth avenue west to Ninth avenue west.

The usual record of sewers constructed has been made upon standard sheets.

The following new divisions of Duluth have been examined and corrected:

DIVISIONS.	Length of Streets in Miles.	Length of Avenues in Miles.	Length of Alleys in Miles.	Total Lengths in Miles.	Area in Acres.	Remarks.
Woodland Park 2nd Division	0.97	0.75	....	1.72	39.08	No Parks.
Grove Hill Park...	0.37	0.25	... .	0.62	10.02	"
Ray's Annex to Portland....	0.13	0.08	0.09	0.30	4.97	"
Windermere........	0.75	0.76	....	1.51	49 63	"
Hunter's Park, 1st Division..	0 30	1.11	....	1.41	35.95	"
Duluth Heights, 5th Division	2.46	0.71	2.04	5.21	74.49	"
Glen Avon, 1st Division.....	1.00	1.44	....	2.44	67.82	"
" " 2nd "	0.39	0.95	....	1.34	34 34	"
" " 3rd "	0.53	0.85	... ...	1.38	42.33	"
" " 4th "	0.70	0.62	....	1.32	42.24	"
Sterling................	0.21	0.17	0.18	0.56	9.96	"
Wooster	0.21	0.18	0.21	0.60	9.94	"
Motor Line Park........ ..	0.25	0.12	0.31	0.68	9.98	"
Chester Park................	0.25	0.02	0.10	0.37	6.19	"
Duluth Heights, 6th Division	4.41	0.50	3.04	7 95	119.80	Court.
Willard & Piper's............	2.44	0.50	1.46	4.40	79.60	No Park.
Totals.......	15.37	9.01	7.43	31.81	636.34 =	.99 sq.m'les

The following number of re-arrangements have been examined and corrected:

Fleischer & Cremer's re-arrangement, block 56, Third Division.
Walbank's re-arrangement, Third street.
Summit Park re-arrangement
Langelier's re-arrangement, block D, Endion.
Warner's re-arrangement, block 141, Third Division.

During the year 141 permits were issued to licensed drain-layers for constructing house-connections to the sewers of the city. To date there have been 837 permits issued.

One branch of office work which does not enter into this report, but upon which much time was necessarily spent, is the preparation of the monthly estimates to contractors. This includes work in detail for each month upon $870,729.99 of work during the progress of each contract.

Respectfully submitted,
M. W. LEWIS,
Assistant City Engineer,
In Charge of Office Work.

ANNUAL REPORT

—OF THE—

Assistant City Engineer,

IN CHARGE OF CONSTRUCTION WORK.

Report of Assistant City Engineer

IN CHARGE OF CONSTRUCTION WORK.

City Engineer's Office,
Duluth, Minn., April 9, 1892.

E. H. Keating, City Engineer:

In accordance with your request the following report of the construction bureau of the Department is respectfully submitted.

The general organization of the Department has been the same as previous years with the exception of the superintendence and inspection of contract work, which has been placed in charge of the Assistant Engineer laying out the work. Formerly the contracts were superintended and inspected by the Assistant Field Engineer. This change, without increasing the force, has much improved the working efficiency of the Department in several respects, and is considered a change for the better. Eight engineers, including their parties, have been engaged the busier part of the year.

Tables 1 to 6 inclusive, give full information in regard to all contract work.

The largest number of inspectors employed at any one time was 29 with 99 contracts in operation, involving an outlay of $870,729.99. The previous year the largest number of inspectors employed was 20, with 106 contracts in operation, involving an outlay of $417,806.81.

There has been 14.6 miles of cross-sectioning and slope-staking done and 24.7 miles of permanent surveys made for the purpose of establishing street and avenue lines and marking the same with monuments. These surveys are made with considerable accuracy by means of a standard tape with corrections for temperature, sag, inclination and tension. The maximum error estimated for this work is about 1 in 50,000.

Monuments have been checked and corrected in new divisions as follows: Sterling Division; Wooster Division; Woodland Park, Second Division; Hunter's Park, First Division; Glen Avon, First Division; Glen Avon, Fourth Division; Windermere Division; Duluth Heights, Fifth Division; Duluth Heights, Sixth Division; Summit Park; Willard & Piper's, amounting in all to a total of 46 monuments. The total number of monuments set by the city during the year is 33. Total number previously set is 216. Total number of monuments in the city at present is 295. Surveys have been made and reference stakes set for 40 additional monuments not yet placed. Table No. 7 gives a complete list of all monuments within the city limits at present date, showing their absolute position.

Several expensive masonry culverts constructed the past five years have been rendered inoperative by the diversion of water from the natural channels to storm sewers, consequently the past year temporary wooden culverts have been constructed over all channels except those constituting a portion of the storm sewer system.

Cast-iron intakes, designed by W. B. Fuller, former City Engineer, were introduced on paved streets and in some respects are superior to the brick intakes.

Considerable difficulty has been encountered in designing an intake or catch-basin that would operate successfully and economically under conditions peculiar to this city. While the corner catch basin was unable to intercept gutter water with velocities ranging from 5 to 20 feet per second the intakes, although not failing in this respect, permitted considerable quantities of loose gravel and material to pass into the sewers where its wearing effect became serious and its removal difficult and expensive. Several sewers constructed on heavy grades have been considerably injured by the passage of foreign material admitted through the intakes, while another has cost $648 in one season for the removal of sediment. As the result a circular catch-basin located at the curb corner, 5 feet in diameter and 8 feet deep, has been adopted, with an outlet 2 feet above the bottom. On grades of 8 per cent and over the catch basin is supplemented with a short line of 12-inch pipe to take the water from under the cross-walk apron on paved streets, and on gravel or macadam streets of over 8 per cent grade the catch-basin is supplemented by an intake designed for high velocities. Whenever considered necessary the catch-basin dimensions are enlarged in order to give increased capacity for sediment.

Delta sewers designed by Mr. Fuller, such as are illustrated and described in his fourth annual report, have been largely constructed the past year in preference to pipe and concrete storm sewers and have given good satisfaction. The cost is from 40 to 50 cents per lineal foot less than for pipe in concrete of the same area.

A 12-ton Springfield steam road roller was purchased the past season and with the Aveling and Porter engine previously owned by the city have been constantly employed in the service of the contractors, who have been charged the uniform rate of $1 per hour for their use. The actual cost of operating the rollers was $1.09 per hour. For 1890 the cost was $1.15 per hour. It is recommended that the future rate be fixed at $1.25 per hour.

The use of tar and Portland cement grout on cedar block pavements has not been generally adopted except in special cases adjacent to street car tracks, at the upper side of streets, at avenue crossings and at other places where there is danger from washouts.

Much difficulty and annoyance have been experienced by contractors failing to complete their contracts within the specified time. Although penalties have been attached to all contracts none have been enforced. It is recommended that deductions made in the approximate and final estimates by the City Engineer for penalties be authorized in the contracts.

Respectfully submitted,
D. A. REED,
Assistant City Engineer,
In Charge of Construction.

TABLE No. 1.

Bridge and Street Improvements.

BRIDGE AND STREET IMPROVEMENTS.

TABLE NO. 1.

Contracts Carried Over from Previous Year.

Location.	From	To	Cubic Yards Earth Moved.		Cubic Yards Rock.	Feet B. M. Timber.	Lineal Feet Stone Curbing.	Square Yards Telford Macadam.	Cubic Yards Gravel Surfacing.	Cubic Yards Masonry.	Square Yards Paving	Cubic Yards Loam.	Piles.	Total Length Under Contract.	Engineer's Estimate of Cost.	Amount of Work Done in 1891	Amount Paid in 1891.	Amount Due on Work Done.	Estimated Amount to Complete.	Work Commenced.	Final Estimate Certified.	Contract Expires.	Contractors.
			Excavation.	Borrow.																			
Ohio avenue	Lake Superior	Eighth street	13,976	3,149	795	987			4,586	29		703				$ 17,651 29	$ 17,651 29				Nov. 30, 1891	Oct. 1, 1891	Hogan & Campbell.
Superior street	Virginia avenue	North city limits	17,052	6,314	406	14,231		20,368	5,937	1,380		4,390				57,003 82	56,503 82		$ 500 00			Sept. 1, 1891	L. Meining & Co.
Bench street	Eighth avenue east	Montana avenue															582 83						Forrestal Bros.
Michigan street	Twenty-fourth avenue west	South city limits	64					2,179								3,075 30	6,990 20				June 1, 1891	June 1, 1891	J. C. Morrison.
Fourth alley	Fifth avenue east	Seventh avenue east							253							227 70	227 70				Sept. 12, 1891		Traff Bros. & Co.
Fourth street	Fifth avenue west	Sixth avenue east	8,262		22	25,923	7,501			103	21.140	171				38,474 61	39,348 40				Oct. 21, 1891		Forrestal Bros.
Piedmont avenue west	Superior street	City limits	8,741		365	3,120			4,299	853		723				12,380 60	13,361 34				Jan. 9, 1892		Joseph Wolf.
Totals			48,095	9,463	1,588	44,261	7,501	22,547	15,125	2,365	21,140	5,987				$ 128,813 32	$ 134.665 58		$ 500 00				
Contracts Ordered During Present Year.																							
Second street	Sixth avenue west	Thirteenth avenue east	26,080		1,520	40,400	16,900			615	42,500	340		8,854	$ 88,278 00	$ 96,541 72	$ 95,041 72		$ 1,500 00	June 1, 1891		Oct. 1, 1891	R. F. Wilson.
Second street	Thirteenth avenue east	Kentucky avenue	23,639	10,935	2,256	25,225	11,806	17,651		1,120				6,058	48,299 00	62,856 44	62.356 44		500 00	April 15, 1891		Oct. 15, 1891	Thomas & Sheridan.
Twenty-fifth avenue west	Michigan street	Eighth stree	6,000			1,953			4,015			516		3,148	5,639 70	10,574 12	10,574 12			May 1, 1891	Aug. 31, 1891	July 1, 1891	A. & D. Sang.
Ninth avenue east	Bench street	Eleventh str et	9,563	19,145	1,164	21,756			3,839	40		924		3,960	22,194 00	20,714 67	20.714 67			April 27, 1891	Nov. 23, 1891	Oct. 31, 1891	Carlson, Traff & Co.
Second street	Seventeenth avenue west	Grand Forks avenue	19,400	19,850	149	17,253			4,259	1,367				5,922	30,459 50	33,384 83	28,377 11	$ 5,007 72	4,000 00	May 1, 1891		July 1, 1892	Davis & Cooper.
Jefferson street	Thirteenth avenue east	Montana av nue	12,874	5,000	30	13,200				935				4,120	19,007 50	14,213 70	12,081 64	2,132 06	1,134 50	May 15, 1891		July 1, 1892	Davis & Cooper.
Oregon avenue	Lake Superior	Fourth street	17,906		857				1.200	202				3,925	17,932 50	11,860 20	10,081 17	1,779 03	4,023 50	April 20, 1891		July 1, 1892	Davis & Cooper.
Pennsylvania avenue	South street	Fourth street	9,904		665		3,386		430	78	6,800	122		2,422	13,554 00	14.715 23	12,507 95	2,207 28	831 70	April 25, 1891		July 1, 1892	Davis & Cooper.
Garfield avenue	Michigan street	Established lock line	26,647	5,947		63,825	15,898			240	40,627			8,367	54,811 00	59.607 32	56,626 95	2,980 37		May 1, 1891		Oct. 31, 1891	Thomas Reilly.
Fifth avenue west	Superior street	Third street	1,663	262	25	2,110	1,960		317		2,899	79		1,032	8,020 00	11,513 78	11,513 78			May 21, 1891	July 20, 1891	July 15, 1891	Zimmerman, Truax & Co.
Piedmont avenue east	Eighth avenue west	North line Third Division	41,930		14,110	18,900		11,405	145	1,914				7,656	64,800 00	74,432 65	63.267 75	11,164 90	32,940 00	May 8, 1891		July 2, 1892	E. J. Amory.
Railroad street	Sixth avenue west	Seventh avenue west				169,562							123	400	4,000 00	3,191 66	3,191 66			June 20, 1891	Aug. 24, 1891	Aug. 1, 1891	W. H. Holden.
Railroad street	Sixth avenue west	Seventh avenue west (painting)														390 00	390 00				Nov. 13, 1891	Nov. 15, 1891	LaVaque Paint & Wall Paper Co.
Railroad street	Fifth avenue west	Sixth avenue west				159,900							131	400	4,000 00	3,877 78	3,877 78			July 6, 1891	Jan. 11, 1892	Sept. 1, 1891	George Taylor
Bench street	Montana avenue	North line East Duluth	19,550		13,070	3,726			1,885	210				7.456	37,000 00	38,628 50	32,834 22	5,794 28	18,509 05	July 1, 1891		July 1, 1892	W. C. Doherty.
Twenty-third avenue west	Michigan street	Piedmont avenue	8,599	41,756	831					135				2.562	26,666 67	25,392 70	24,892 70	500 00	400 00	July 1, 1891		Dec. 1, 1891	Zimmerman & Bunnell.
Superior street	Twenty-eighth avenue west	South city limits	20,891	7,586	8	647.064							232	3,291	22,000 00	26,438 02	26,438 02			Aug. 12, 1891	Jan. 22, 1892	Nov. 1, 1891	Meniece & Norris.
Third alley	Fourth avenue east	Sixth avenue east	883			19,541			178					866	936 56	887 29	887 29			Aug. 26, 1891	Dec. 11, 1891	Nov. 1, 1891	Mike Fitzgerald.
Superior street	Twenty-second avenue west	Twenty-sixth avenue west	754	10.962	14					635				700	7,030 00	12,009 81	11,709 81		300 00	Oct. 1, 1891		Dec. 1, 1891	Fredin, Wilson & Co.
Second alley	Eighteenth avenue west	Twenty-eighth avenue west	4,184	9,030		24,495				190				4,594	14,000 00	7,196 76	6,117 25	1,079 51	3,103 20	Oct. 15, 1891		July 1, 1892	A. & D. Sang.
Sixth alley	Third avenue east	Fourth ave ue east		800		14,800								400	518 60	445 15	378 38	66 77	422 95	Oct. 16, 1891		Nov. 15, 1891	E. J. Amory.
Third street	Twenty-eighth avenue west	West city limits	3,180		40	37,000								2,314	4,500 00	1,646 00	1,399 10	246 90	2,480 40	Oct. 20, 1891		Dec. 1, 1891	J. A. McLean & Co.
Sixth avenue west viaduct	Sixth avenue west	South End viaduct				116,700							117	400	3,250 00	2,833 83	2,692 14	141 69	400 00	Nov. 10, 1891		Dec. 31, 1891	W. H. Holden.
Fulton street dock			18	391		15,002							24	270	877 80	817 93	817 93			May 1, 1891	Aug. 17, 1891	June 1, 1891	Samuel Meniece.
Totals			253,665	131,664	34,739	1,412,412	49,950	29,056	16,268	7,681	92,826	1,981	627	79,117	$ 497,774 83	$ 534,170 09	$ 498,769 58	$ 33,100 51	$ 70,545 30				
Totals fiscal year			301,760	141,127	36,327	1,456,673	57,451	51,603	31.393	10,046	113,966	7,968	627	79,117	497,774 83	662,983 41	633,435 16	33,100 51	71,045 30				
Totals reported March 1, 1891			803,130	355,068	228,608	6,856,506	73,761	78,548	121,978	56,588	153,240	4,959	408	236,973	1,784,327 57	1,705,821 60	1,687,808 19						
Totals to March 1, 1892			1,104,890	496,195	264,935	8,313,179	131,212	120,151	153,371	66,634	267,206	12,927	1,035	316,090	2,282,102 40	2,368,805 01	2,321,243 35						
Sprinkling Contracts.																							
District No. 5																$ 717 17	$ 717 17			June 4, 1891		Nov. 1, 1891	Charles Peterson.
District No. 6																718 17	718 17			June 4, 1891		Nov. 1, 1891	Charles Peterson.
District No. 1																740 00	740 00			June 3, 1891		Nov. 1, 1891	M. Haug & Bro.
District No. 2																853 33	853 33			June 3, 1891		Nov. 1, 1891	M. Haug & Bro.
District No. 3																725 00	725 00			June 3, 1891		Nov. 1, 1891	M. Haug & Bro.
District No. 4																853 33	853 33			June 3, 1891		Nov. 1, 1891	M. Haug & Bro.
Total																$ 4,607 00	$ 4,607 00						

TABLE No. 2.

Sanitary Sewer Contracts.

TABLE No. 2.

SANITARY SEWER CONTRACTS.

Contracts Carried Over from Previous Year.

Location.	From	To	Length under Contract.	Length Built During 1891.	Engineer's Estimate.	Amount of Work Done in 1891.	Amount Paid in 1891.	Amount Yet Due on Work Done.	Estimated Amount to Complete.	Work Commenced.	Final Estimate Certified.	Contract Expires.	Five Per Cent. Certified.	Contractors.
Superior street	Fourteenth avenue west	Nineteenth avenue west		266		$1,439 78	$2,621 59				June 1, 1891		December 7, 1891	Forrestal Bros.
Superior street	Fourteenth avenue east	Eighteenth avenue east		1,574		3,318 37	4,031 84				October 3, 1891		December 4, 1891	Forrestal Bros.
Fourth alley	Fifth avenue east	Tenth avenue east		709		3,880 40	4,206 62				June 20, 1891		December 12, 1891	John Hogan.
Jefferson street	Fourteenth avenue east	Ohio avenue		1,604		4,233 97	4,421 43				July 11, 1891		January 4, 1892	Steele & O'Connell.
				4.153		12,872 52	15,281 48							

Contracts Ordered During Present Year.

Location.	From	To	Length under Contract.	Length Built During 1891.	Engineer's Estimate.	Amount of Work Done in 1891.	Amount Paid in 1891.	Amount Yet Due on Work Done.	Estimated Amount to Complete.	Work Commenced.	Final Estimate Certified.	Contract Expires.	Five Per Cent. Certified.	Contractors.
Second street	Fourteenth avenue east	Ohio avenue	2,185	2,185	$5,716 00	$7,561 20	$7,183 14	$378 06		April 14, 1891.	December 7, 1891.	October 15, 1891.		Thomas & Sheridan
Fifth alley	Lake avenue	Fifth avenue west	2,549	2,549	3,545 90	5,283 16	5,019 00	264 16		April 20, 1891	August 28, 1891.	July 1, 1891		Carlson Traff & Co.
Twenty-sixth avenue west	Second alley	Second street	174	174	462 90	507 38	431 27	76 11		May 1, 1891.		July 1, 1892		Davis & Cooper.
Second street	Seventeenth ave west	Grand Forks avenue	5,020	5,020	10,133 90	11,107 77	9,441 61	1,666 16		May 1. 1891		July 1, 1892		Davis & Cooper.
Second alley	Piedmont avenue west	Twenty-eighth avenue west	4,572	4,554	9,062 00	29,432 77	19,411 13	1,021 64		April 13, 1891	September 21, 1891	September 1, 1891.		Zimmerman, Truax & Co.
Fifth street	200 feet west Second avenue east	Sixth avenue east	2,077	2,077	4,362 70	3,352 82	3,185 18	167 64		April 14, 1891	September 18, 1891	July 15, 1891		W. C. Doherty.
First street	Thirteenth avenue east	Fourteenth avenue east	308	283	830 00	1,050 90	1,050 90			May 1, 1891	June 13. 1891	July 1, 1891	December 12, 1891	L. Meining & Co.
Seventh avenue west	Second street	Third street	297	297	373 00	417 20	417 20			April 28, 1891	May 29. 1891	June 1, 1891	December 28, 1891	J. D. O'Connell.
First street	Seventeenth avenue west	Twenty-second avenue west	2,318	2,318	8,453 00	9,847 31	9,354 94	492 37		June 11, 1891	September 28, 1891	September 1, 1891.		Joseph Wolf.
Third street	Fourteenth avenue east	Pennsylvania avenue	1,303	1,303	2,963 00	2,506 00	2,380 70	125 30		July 5, 1891	September 11, 1891	September 1, 1891.		C. M. Johnson.
First Street	Missouri avenue	Montana avenue	891	891	1,156 60	1,426 34	1,283 71	142 63		July 25, 1891	November 21, 1891	October 1, 1891		W. C. Doherty.
Center street	Ohio avenue	Indiana avenue	507	507	727 50	583 46	554 29	29 17		August 28, 1891	September 11, 1891	September 15, 1891		J. F. Myhrberg.
Second alley	Fourteenth avenue east	New York avenue	468	468	575 00	516 54	490 71	25 83		October 15, 1891	November 16, 1891	October 15, 1891		C. M. Johnson.
First alley	Ohio avenue	Oregon avenue	979	979	2,303 40	1,677 60	1,425 96	251 64	$681 95	September 26, 1891		November 1, 1891.		Mitchell & Watson.
First alley	Fourteenth avenue east	New York avenue	476	476	615 00	709 09	673 64	35 45		November 19, 1891	December 11, 1891	December 1, 1891		J. F. Myhrberg & Co.
Sixth alley	Third avenue east	Fourth avenue east	494	494	650 05	876 00	744 60	131 40		October 16, 1891		November 15. 1891		E. J. Amory.
Totals			24,575	24,575	$51,929 95	$67,855 54	$63,047 98	$4,807 56	$691 95					
Totals for fiscal year			24,575	28,728	$51,929 95	$80,728 06	$78,329 46							
Totals reported previous year				100,865		$332,726 28	$328,985 06							
Totals to date				129,593		$413,454 34	$407,314 52	$4,807 56						

TABLE No. 3.

Storm Sewer Contracts.

TABLE NO. 3.

STORM SEWER CONTRACTS.

Contracts Carried Over from Previous Year.

Location.	From	To	Length Under Contract.	Length Built During 1891.	Length Unfinished	Engineer's Estimate.	Amount of Work Done During Year.	Amount Paid During 1891.	Amount Yet Due on Work Done.	Estimated Amount to Finish.	Work Commenced.	Final Estimate Certified.	Contract Expires.	Five Per Cent Certified.	Contractors.
Ohio avenue	Lake Superior	Seventh street		1,049			$ 7,823 80	$ 7,432 61	$ 391 19			November 30, 1891	October 1, 1891		Hogan & Campbell.
Total				1,049			$ 7,823 80	$ 7,432 61	$ 391 19						

Contracts.

Location.	From	To	Length Under Contract.	Length Built During 1891.	Length Unfinished	Engineer's Estimate.	Amount of Work Done During Year.	Amount Paid During 1891.	Amount Yet Due on Work Done.	Estimated Amount to Finish.	Work Commenced.	Final Estimate Certified.	Contract Expires.	Five Per Cent Certified.	Contractors.
Twenty-fifth avenue west	Michigan street	Eighth street	1,437	1,437		$ 4,160 30	$ 4,169 54	$ 4.169 54			May 1, 1891	August 31, 1891	July 1, 1891		A. & D. Sang.
Ninth avenue east	Bench street	Tenth street	3,627	3,627		14,267 55	18,304 51	17,389 28	$ 915 23		April 27, 1891	November 23, 1891	October 1, 1891		Carlson, Traff & Co.
Twenty-second avenue west	Michigan street	Second street	890	890		15,865 90	17,390 61	14,782 02	2,608 59		May 1, 1891		July 1, 1892		Davis & Cooper.
Oregon avenue	Lake Superior	Fourth street	3,925	3,925		23,910 00	15,905 50	13,519 68	2,385 82		April 20, 1891		July 1, 1892		Davis & Cooper.
Pennsylvania avenue	Lake Superior	Fourth street	2,683	2,683		10,169 40	10,648 98	9,051 63	1,597 35		April 25, 1891		July 1, 1892		Davis & Cooper.
Second street	Seventeenth avenue west	Twenty-second avenue west	2,297	2,297		6,127 30	6,716 13	5,708 71	1,007 42		May 1, 1891		July 1, 1892		Davis & Cooper.
Lake avenue	Fifth street	Piedmont avenue east	1,119	1,119		4,949 00	6,243 16	5,931 00	312 16		July 28, 1891	September 11, 1891	September 1, 1891		E. J. Amory.
Twenty-third avenue west	Michigan street	Piedmont avenue west	4,803	4,803		34,133 33	31,993 20	30,393 54	1,599 66	$ 162 00	July 1, 1891		December 1, 1891		Zimmerman & Bunnell.
Totals for fiscal year			20,781	21,830		$113,582 78	$119,195 43	$108,378 01	$ 10,817 42	$ 162 00					
Totals reported previous year				41,657			$215,059 05	$211,419 19							
Totals to date				63,487			$334,254 48	$319,797 20	$ 10,817 42						

TABLE No. 4.

Description of Sanitary Sewers.

DESCRIPTION OF SANITARY SEWERS.

TABLE NO. 4.

Location.	From	To	Excavation.		Pipe.										Brick.																									
			Earth.	Rock.	6 in.	8 in.	9 in.	10 in.	12 in.	15 in.	18 in.	20 in.	21 in.	24 in.	1 ft. 6 in. x 2 ft. 3 in.	1 ft. 8 in. x 2 ft. 6 in.	2 ft. 2 in. x 3 ft. 3 in.	2 ft. 4 in. x 3 ft. 6 in.	1 ft. 9 in. x 2 ft. 8 in.	1 ft. 10 in. x 2 ft. 9 in.	2 ft. 10 in. x 3 ft.	2 ft. 2 in. x 3 ft. 4 in.	2 ft. 6 in. x 3 ft. 9 in.	2 ft. 10 in. x 4 ft. 3 in.	3 ft. x 4 ft. 6 in.	3 ft. 6 in.	3 ft. 9 in.	4 ft.	4 ft. 7 in.	Wood.	Manholes.	Flushing Tanks.	Inlets.	Lampholes.	Catch Basins.	Masonry.	Concrete.	Timber.	Length Built in 1891.	
Second street	Fourteenth avenue east	Ohio avenue	1,835	674	....	879	466	474	....	....	204	162	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	7	1	142	....	....	....	....	....	2,185	
Fifth alley	Lake avenue	Fifth avenue west	3,165	156	124	484	442	....	1,623	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	7	1	174	....	....	....	....	....	2,549	
Twenty-sixth avenue west	Second alley	Second street	....	....	....	....	....	....	....	....	174	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	4	302	....	....	648	....	52,546	5,194	
Second street	Seventeenth avenue west	Twenty-eighth avenue west	1,761	....	544	2.876	968	468	688	....	....	....	....	90	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
Second alley	Piedmont avenue west	Twenty-eighth avenue west	8,958	4	....	1,300	499	....	947	....	....	....	....	....	....	....	425	1,401	....	....	....	....	....	....	....	....	....	....	....	....	10	2	290	....	....	463	....	36,349	4,572	
Fifth street	200 feet west Second avenue east	Sixth avenue east	2,084	65	....	1,179	898	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5	2	153	....	4	....	....	....	2,077	
First street	Thirteenth avenue east	Fourteenth avenue east	142	51	....	308	....	....	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	....	8	....	....	87	....	....	308	
Seventh avenue west	Second street	Third street	127	41	297	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	8	1	....	....	....	....	297	
First street	Seventeenth avenue west	Twenty-second avenue west	3,575	212	150	380	....	....	532	....	466	....	....	....	....	....	506	....	....	433	....	....	....	....	....	....	....	....	....	....	7	1	75	....	....	2	....	4,287	2,318	
Third street	Fourteenth avenue east	Pennsylvania avenue	632	8	102	940	....	....	....	....	363	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5	....	79	....	....	....	....	....	1,303	
First street	Missouri avenue	Montana avenue	726	99	....	891	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	67	1	....	....	....	....	891	
Center street	Ohio avenue	Indiana avenue	411	5	....	....	507	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	....	34	....	....	....	....	....	507	
Second alley	Fourteenth avenue east	New York avenue	416	....	....	....	468	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	....	17	....	....	....	....	....	468	
First alley	Ohio avenue	Oregon avenue	860	160	....	979	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	....	37	....	....	....	....	....	979	
First alley	Fourteenth avenue east	New York avenue	508	17	....	....	....	476	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	....	17	....	....	....	....	....	476	
Sixth alley	Third avenue east	Fourth avenue east	375	....	....	....	....	494	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	....	18	....	....	....	....	....	494	
Totals for fiscal year			25,575	1,492	1,217	10,216	4,248	1,912	3,794	....	1,207	162	....	90	....	....	931	1,401	....	433	....	....	....	....	....	....	....	....	....	....	58	12	1,421	2	4	1,200	....	93,182	24,618	4.66 miles.
Totals for previous year			118,099	27,282	658	38,422	13,041	11,414	11,724	4,927	3,633	2,310	160	1,316	1,396	466	....	....	1,875	4;189	632	457	466	467	1,424	466	466	458	418	300	240	52	3,931	127	1	332	26	304,364	100,699	19.07 miles.
Total in operation			143,674	28,774	1,875	48,638	17,289	13,326	15,518	4,927	4,840	2,472	160	1,406	1,396	466	931	1,401	1,875	4,622	632	457	466	467	1,424	466	466	458	418	300	298	64	5,352	129	5	1,532	26	397,546	125,317	23.73 miles.

TABLE No. 5.

Description of Storm Water Sewers.

DESCRIPTION OF STORM WATER SEWERS.

TABLE NO. 5.

Location.	From	To	PIPE SEWERS.							CONCRETE SEWERS.								BRICK SEWERS.									MASONRY SEWERS.					CATCH BASINS.						Tunnel.	Manholes.	Piles.	Masonry.	EXCAVATION.		Timber.	Length.	Contractors.
			10 in.	12 in.	15 in.	18 in.	20 in.	21 in.	24 in.	26 in.	28 in.	30 in.	32 in.	34 in.	36 in.	40 in.	44 in.	26 in.	28 in.	32 in.	36 in.	39 in.	40 in.	44 in.	45 in.	48 in.	4 ft. x 6 ft.	10 ft. x 16 ft.	5 ft. x 7 ft.	2½ ft. x 5 ft.	2½ ft. x 4 ft.	No 1.	No. 2	No. 3	No. 5	Special.	Hering & Rosewater.					Earth.	Rock.			
Twenty-fifth avenue west	Michigan street	Eighth street		936	532	6												905														1	18		5				8		4	2,098	4		1,437	A. & D. Sang.
Ninth avenue east	Superior street	Tenth street	16	1,374		118												2,227			1,242										226	2	44						20		773	4,227	416		3,695	Carlson, Traff & Co.
Oregon avenue	Lake Superior	Fourth street		1,409	62													1,102	891	1,298												2	43						18		226	3,166	632		3,291	Davis & Cooper.
Pennsylvania avenue	Lake Superior	Fourth street		1,296														2,685															16	16					14		16	3,749	452		2,683	Davis & Cooper.
Ohio avenue	Lake Superior	Seventh street		724	229	734	315																									9	36						8			1,210	520	4.520	1,278	Hogan & Campbell.
Lake avenue	Fifth street	Piedmont avenue east		464	527													1,119														3	14			1			7			2 234	198	708	1,119	E. J. Amory.
Twenty-third avenue west	Michigan street	Piedmont avenuc west		1,429	148													3,502									1,139					1	39						21			6,741	1,394		4.641	Zimmerman & Bunnell.
Second street	Seventeenth avenue west	Twenty-second avenue west			86							503				468	472	897																					16			6,272	43		2,340	Davis & Cooper.
Twenty-second avenue west	Michigan street	Second street																									674		487												1,890	5,071				Davis & Cooper.
Totals for fiscal year			16	7,632	1,584	858	315					503				468	472	12,435	891	1,298	1,242						1,813		487		226	18	210	16	5	1			112		2,909	34,768	3,659	5,228	20,484	3.88 miles.
Totals to March 1, 1891			104	1,183	7,699	5,883	2,713	4,656	9,714	456	2,026	397	131	157	98			1,175		220	1,606	299	713	1,104	489	708	191	134	336	235	108	73	231	7	27	8	63	259	191	220	3,113	51,794	7,573	61,002	42,505	8.05 miles.
Totals to March 1, 1892			120	8,815	9,283	6,741	3,028	4,656	9,714	456	2,026	900	131	157	98	468	472	13,610	891	1,518	2,848	299	713	1,104	489	708	2,004	134	823	235	334	91	441	23	32	9	63	259	303	220	6,022	86,562	11,232	66,230	62,989	11.93 miles.

TABLE No. 6.

Sidewalks.

TABLE No. 6.

SIDEWALKS.

Contracts Carried Over.

Location.	Side.	From	To	Three Feet.			Six Feet.			Eight Feet.			Ten Feet.			Twelve Feet.			Sixteen Feet.			Price per Lineal Foot	Total Cost.	Paid to Contractors.	Contractors.
				Built by			Built by			Built by			Built by			Built by			Built by						
				Owner.	Contractor.	Total.	Owner.	Contractor.	Total.	Owner.	Contractor.	Total.	Owner.	Contractor.	Total.	Owner.	Contractor.	Total.	Owner.	Contractor.	Total.				
Superior street	North and south	Thirteenth avenue east	Indiana avenue								2259.5	2259.5										.31.34	$734 15	$734 15	Colby Smith.
Contracts Ordered in 1891.																									
Bench street	South	Eighth avenue east	Tenth avenue east							113.7	511.9	625.6										.35.0	$220 76	$180 97	Colby Smith.
Near Railroad street		Fifth avenue west	Sixth avenue west								523.0	523.0										.35.0	197 35	197 35	John Boyer.
Twelfth avenue east	West	Fourth street	Fifth street		300.0	300.0																.13.5	40 50	40 50	Edw. Low.
Twenty-eighth avenue west	West	Superior street	Railroad alley	309.0	804.3	1113.3																.12.0	133 64	96 56	J. W. Preston.
Seventh street	South	Fourth avenue east	Fifth avenue east				350.0	62.5	412.5													.38.0	156 75	23 75	J. W. Preston.
Piedmont avenue west	North	Superior street	Seventh street							320 1	2674.8	2994.9										.32.5	3037 57	2,865 15	Edw. Low.
Piedmont avenue west	South	Superior street	Twenty-fourth avenue west							166.7	4823.2	4989.9										.41.0			
Fifth street	North	Twenty-third avenue west	Twenty-fourth avenue west	147.0	266.5	413.5																.22.0	90 97	58 63	Edw. Low.
Fifth street	North	Fifth avenue west	Sixth avenue west							201.0	218.4	419.4										.45.0	188 73	98 28	Edw. Low.
Twelfth avenue east	West	Fifth street	Sixth street					321.5	821.5													.28.0	90 02	90 02	Edw. Low.
Fifth avenue west	East	Michigan street	St. P. & D. R. R.											211.5	211.5							.45.0	95 18	95 18	Edw. Low
Twenty-fifth avenue west	East and west	Michigan street	Eighth street							843.6	4420.8	5264.4										.31.5	1,658 28	1,392 55	Jens Solem.
Piedmont avenue west	North	Seventh street	Ninth street							69.3	994.2	1063.5										.32.0	340 33	318 14	Jens Solem.
First street	North	Tenth avenue west	Twelfth avenue west							6.0	902.8	908.8										.34.0	310 24	308 20	Jens Solem.
New York avenue	West	Superior street	Fourth street				149.4		149.4	150.6	1551.4	1702.0										.31.5	583 19	488 69	Anderson & Landfold
Superior street	North	Seventh avenue east	Eighth avenue east													194.9	2414.9	3609.8				.48.0	1,264 90	1,171 35	Anderson & Landfold
Twenty-second avenue west	West	Third street	Fourth street		314.0	314.0																.11.9	37 37	37 37	Edw. Low.
Superior street	South	Twenty-seventh avenue west	Twenty-eighth avenue west								423.6	423.6										.33.0	139 79	139 79	Edw. Low.
Garfield avenue	East and west	Michigan street	Dock line										331.9	7428.5	7760.4							.39.73	3,083 20	2,951 34	John Matson.
Bench street	South	Montana avenue	Oregon avenue								418.0	418.0										.33.0	137 94	137 94	J.W.Preston.
Third street	North	Fourth avenue east	Sixth avenue east							49.5	802.3	851.8										.34.0	289 61	272 78	Arnt Anderson.
First street	North	Sixth avenue west	Seventh avenue west							26.0	402.4	428.4										.33.0	141 37	132 79	J.W.Preston.
Third street	North	Lake avenue	First avenue east							70.4	351.1	421.5										.34 5	145 43	121 13	Edw. Low.
Third street	North	Second avenue east	Third avenue east							24.0	401.5	425.5										.34.0	144 67	136 51	Arnt. Anderson.
Jefferson street	North and south	Thirteenth avenue east	Oregon avenue Ohio avenue								4250.0	4250.0										.33.0	1,421 25	1,350 19	Edw. Low.
Ohio avenue	East and west	Southerly end	Eighth street					1500.0	1500.0													.27.0	405 00	344 25	Barlett & Olson.
Oregon avenue	East	Southerly end	Fourth street																			.27.0			Bartlett & Olson.
Pennsylvania avenue	West	South side Fourth street	London Road							53.5	1886.3	1939.8										.31.5	613 53	596 68	Sullivan & Hackett.
Second street	North and south	Piedmont avenue west	Grand Forks avenue								8738.0	8738.0										.33.0	2,945 00	2,797 75	Edw. Low.
Garfield avenue	West	125 feet north of Ash avenue	Oak avenue										600.0	2651.3	3251.3							.40.95	1,332 66	1,086 96	John Boyer.
Garfield avenue	West	Michigan street	St. P. & D. R. R.																10.8	314.1	324.9	.72.74	239 34	231 48	John Boyer.
Crosswalks																							1,900 26	1,900 26	Preston & Low. J. W. Preston.
				456.0	1684.8		499.4	1884.0		2094.4	36553.2		931.9	10291.3		194.9	2414.9		10.8	314.1			$22.118 94	$20,396 69	
						2140.8			2383.4			38647.6			11223.2			3609.8			324,9				11.05 miles.

TABLE OF MONUMENTS.

TABLE No. 7.

LOCATION.				DESCRIPTION.	
STREET.		AVENUE.		MATERIAL.	POINT.
Name.	Line.	Name.	Line.		
Alder	Center	Highland	Center	Granite	cross
“	“	Oak	“	“	“
Balsam	“	Highland	“	“	“
Banian	“	“	“	“	“
Bench	6 ft no of S line	10 east	25 ft west of C	Granite mon	copper bolt
“	“ “	12 east	“ “	“ “	“ “
“	“ “	14 east	“ “	“ “	“ “
“	“ “	15 east	“ “	“ “	“ “
“	“ “	16 east	“ “	“ “	“ “
“	“ “	17 east	22 ft west of C.	“ “	“ “
“	“ “	18 east	25 ft west of C	“ “	“ “
“	“ “	19 east	“ “	“ “	“ “
“	“ “	20 east	“ “	“ “	“ “
“	“ “	22 east	West line	Sandstone m	cross
“	North line	23 east	East line	“ “	“
“	6 ft no of S line	24 east	West of	Solid rock	“
“	“ “	27 east	East line	Stone mon	“
“	27 ft s of C line	9 east	25 ft west of C	Granite mon	copper bolt
“	“ “	13 east	“ “	“ “	“ “
Bay V. T.	South line	Diamond	Center	Stone mon	cross
By. Terrace	“ “	Marshall	“	“ “	“
Birch	Center	Lincoln	“	2 in iron pipe	Plug & cross
“	“	Arthur	“	“ “	“ “
Cascade	Near Center	24 west	“	Stone mon	cross
“	South line	22 west	“	“ “	“
Cedar	Center	Lincoln	“	2 in iron pipe	Plug & cross
“	“	Arthur	“	“ “	“ “
Courtland	153.5 north of north line.	26 West	“	Stone mon	cross
Carlisle	†230 ft S of C	Woodland	30 ft west of C	Sandstone	hole
“	†60 “ “	Woodland	“ “	“	“
Eighth	Center	16 west	East line	Granite mon	cross
“	South of	5 west	Center	Rock	“
“	North of	5 west	“	“	“
“	Near	2 west	“	“	“
“	†30 ft south	2 east	“	Boulder	“
“	Center	19 east	East line	Granite mon	“
“	25 ft S of C	Lake	25 ft west of C	“ “	“
Eleventh	“ “	Lake	“ “	“ “	“
“	Center	16 west	East line	“ “	“
“	“	19 east	“	“ “	“
Euclid	“	Marshall	Center	Stone mon	“
“	“	Laurel	“	“ “	“
First	“	14 west	†50 ft east	Ledge	“
“	“	13 west	†100 ft east.	“	“
“	“	9 west	(High point)	“	“
“	“	8 west	West of	“	“
“	†70 ft north	6 east	Center.	Rock	“
“	Center	19 east	East line	Granite mon	copper bolt
“	“	24 east	“	Stone mon	cross
“	“	Michigan	Center	Granite mon	“
Fifth	“	28 west	East line	“ “	“
“	“	16 west	“	Rock	“
“	“	8 west	†100 ft east	“	“
“	“	7 west	50 to 75 ft east	Solid rock	“
“	“	3 west	†60 ft east	Ledge	“
“	“	2 east	†150 ft west	Boulder	“
“	“	13 east		Cement v'ult	cross on par
“	“	19 east	East line	Granite mon	cross
“	25 ft n of Center	1 east	25 west of C	“ “	“
“	“ “	3 east	“ “	“ “	“
“	“ “	5 east	“ “	“ “	“

TABLE OF MONUMENTS—CONTINUED.

LOCATION.				DESCRIPTION.	
STREET.		AVENUE.		MATERIAL.	POINT.
Name.	Line.	Name.	Line.		
Fifth	25 ft no of C	7 east	25 west of C	Granite mon	cross
"	" "	9 east	" "	" "	"
"	" "	11 east	" "	" "	"
"	" "	1 west	" "	" "	"
"	" "	3 west	" "	" "	"
"	" "	5 west	" "	" "	"
"	" "	7 west	" "	" "	"
"	" "	9 west	" "	" "	"
"	" "	13 west	" "	" "	"
Faribault	†30 ft S of C	Woodland	Center	Sandstone m	"
Fifteenth	Center	16 west	East line	Granite mon	"
"	"	15 west	Center	" "	"
"	"	14 west	"	" "	"
"	"	13 west	"	" "	"
"	"	12 west	"	" "	"
"	"	11 west	"	" "	"
"	"	10 west	"	" "	"
"	"	9 west	"	" "	"
"	"	8 west	"	" "	"
"	"	7 west	"	" "	"
"	"	6 west	"	Ledge	"
"	"	5 west	"	Granite mon	"
"	"	4 west	"	" "	"
"	"	3 west	"	" "	"
"	"	2 west	"	" "	"
"	"	1 west	"	" "	"
"	"	Lake	"	" "	"
"	"	1 east	"	" "	"
"	"	2 east	"	" "	"
"	"	3 east	"	" "	"
"	"	4 east	"	" "	"
"	"	5 east	"	" "	"
"	"	6 east	"	" "	"
"	"	7 east	"	" "	"
"	"	8 east	"	" "	"
"	"	9 east	"	" "	"
"	"	10 east	"	" "	"
"	"	11 east	"	" "	"
"	"	12 east	"	" "	"
"	"	13 east	"	" "	"
"	"	14 east	"	" "	"
"	200 ft south	14 east	"	Rock	"
"	Center	15 east	"	Granite mon	"
"	75 ft south	16 east	"	Large rock	"
"	Center	16 east	"	Granite mon	"
"	"	17 east	"	" "	"
"	"	18 east	"	" "	"
"	"	19 east	East line	" "	"
Forest	South line	E Diamond	Center	Stone mon	"
"	"	Diamond	"	" "	"
Fourth	Center	28 west	East line	Granite mon	"
"	"	16 west	"	Ledge	"
"	†100 ft north	8 west	Center	Boulder	"
"	†75 ft south	16 east	Center line	Rock	"
"	Center	19 east	East line	Granite mon	Copper bolt
"	25 ft S of C	Lake	25 west of C	" "	cross
"	" "	4 east	" "	" "	"
"	" "	6 east	" "	" "	"
"	" "	10 east	" "	" "	"
"	" "	12 east	" "	" "	"
"	" "	14 east	" "	" "	"
"	" "	16 east	" "	" "	"

TABLE OF MONUMENTS—CONTINUED.

LOCATION.				DESCRIPTION.	
STREET.		AVENUE.		MATERIAL.	POINT.
Name.	Line.	Name.	Line.		
Fourth	25 ft S of C	18 east	25 ft west of C	Granite mon	cross
“	“ “	2 west	“ “	“ “	“
“	“ “	4 west	“ “	“ “	“
“	“ “	6 west	“ “	“ “	“
“	“ “	8 west	“ “	Granite	“
“	“ “	10 west	“ “	“	“
“	Center	Dakota	Center	Sandstone	hole
“	“	Kentucky	220 ft east of C	“	“
Fourteenth	“	16 west	East line	Granite mon	cross
“	North line	9 west	West line	“ “	“
“	Center	19 east	East line	“ “	“
Grand View	South line	Hill	“ “	Stone mon	“
Henry	Center	Piper	North line	“ “	“
Locust	“	Ebony	Center	Granite mon	“
“	“	Oak	“	“ “	“
Lewis	†143 ft S of C	Woodland	30 ft W of C	Sandstone m	hole
Martin	†100 ft south of south line	26 west	Center	Stone mon	cross
Marshall	Center	Grand View	“	“ “	“
Michigan	“	35 West	Near W city lim	Granite mon	copper bolt.
“	“	28 west	East line	“ “	“ “
“	14 ft N of C	1 “	25 ft W of C	“ “	“ “
“	“ “	3 “	“ “	“ “	“ “
“	“ “	5 “	“ “	“ “	“ “
“	“ “	7 “	“ “	“ “	“ “
“	“ “	8 “	“ “	“ “	“ “
“	20 ft S of C	10 “	“ “	“ “	“ “
“	“ “	11 “	“ “	“ “	“ “
“	“ “	12 “	“ “	“ “	“ “
“	“ “	13 “	“ “	“ “	“ “
Mulberry	Center	Ebony	Center	“ “	cross
Myrtle	“	Highland	“	“ “	“
“	“	Ebony	“	“ “	“
Ninth	“	16 west	East line	“ “	“
“	About	10 “	Center line	Rock	“
“	†120 ft south	6 “	Center	“	“
“	†100 ft north	3 “	Center line	“	“
“	†150 ft north	6 east	“ “	“	“
“	Center	19 “	East line	Granite mon	“
Oxford	†150 N of C	Woodland	30 ft W of C	Sandstone m	hole
Orange	South	Highland	East	Granite mon	cross
“	“	Ebony	“	“ “	“
Park	South line	Piedmont	Center	Stone mon	“
“	“ “	E Diamond	“	“ “	“
Palmetto	“ “	Highland	East	Granite mon	“
“	“ “	Ebony	“	“ “	“
Petre	Center	Woodland	6 ft west of C	Sandstone m	hole
“	“	Cumberl’nd	Center	“ “	“
Piedmo’t av	20 ft south of C.	Near 9th W.	At end of curve	Granite mon	copper bolt.
Railroad	Center	Lake	Center	Stone mon	cross
Ruthvin	†310 S of C	Woodland	30 ft W of C	Sandstone m	hole
“	†330 N of C	“	“ “	“ “	“
Seventh	Center	16 west	East line	Stone mon	cross
“	South of	2 “	Center	Rock	“
“	†30 ft south	1 “	“	“	“
“	†20 ft north	2 east	“	Boulder	“
“		4 “	“	“	“
“	Center	19 “	East line	Stone mon	“
“	25 ft S of C	Lake	25 ft west of C	Granite mon	“
Second	Center	16 west	East line	“ “	“
“	“	15 “	†100 ft west	Rock	“
“	“	15 “	†130 ft east	“	“

TABLE OF MONUMENTS—Continued.

LOCATION.				DESCRIPTION.	
STREET.		AVENUE.		MATERIAL.	POINT.
Name.	Line.	Name.	Line.		
Second	Center	10 west	†30 ft east	Rock	cross
“	“	10 west	†45 “	“	“
“	“	10 west	†79 “	“	“
“	†60 ft north	4 east	Center	“	“
“	Center,	19 east	East line	Granite mon	“
“	25 ft S of C	Lake	25 ft west of C	“ “	“
“	“ “	10 east	“ “	“ “	“
“	“ “	12 east	“ “	“ “	“
“	“ “	4 east	“ “	“ “	“
Sixth	Center	28 west	East line	Boulder	“
“	“	27 west	Center	Stone mon	“
“	“	16 west	East line	Solid rock	“
“	Near center	3 west	Center line	Rock	“
“	Center	19 east	East line	Granite mon	“
“	North line	25 east	“	Stone mon	“
“	North line	27 east	“	“	“
“	25 ft S of C	Lake	25 ft west of C	Granite mon	“
Sixteenth	South line	17 west	East line	Stone mon	hole
“	Center	16 west	“	Granite mon	cross
“	South line	10 west	West line	Stone mon	“
“	“	9 west	“	Solid rock	“
“	Center	19 east	East line	Granite mon	“
“	South	2 west	“	Sandstone	“
S line of Div		Woodland	Center	Sandstone m	hole
Superior	20 ft south of C	28 west	East line	Granite mon	copperbolt
“	“ “	27 west	25 ft west of C	“ “	“ “
“	“ “	25 west	“ “	“ “	“ “
“	“ “	24 west	“ “	“ “	“ “
“	“ “	23 west	“ “	Boulder	“ “
“	“ “	22 west	“ “	Granite mon	“ “
“	“ “	21 west	“ “	“ “	“ “
“	“ “	20 west	“ “	“ “	“ “
“	“ “	19 west	“ “	“ “	“ “
“	“ “	18 west	“ “	“ “	“ “
“	“ “	17 west	“ “	“ “	“ “
“	“ “	16 west	East line	“ “	“ “
“	“ “	14 west	Near east line	Solid rock	cross
“	“ “	10 west	†70 ft west	“	“
“	“ “	8 west	†100 ft west	“	“
“	“ “	7 west	25 ft west of C	Granite mon	copperbolt
“	“ “	6 west	“ “	“ “	“ “
“	“ “	5 west	“ “	“ “	“ “
“	“ “	4 west	“ “	“ “	“ “
“	“ “	3 west	“ “	“ “	“ “
“	“ “	2 west	“ “	“ “	“ “
“	“ “	1 west	“ “	“ “	“ “
“	“ “	Lake	Center	“ “	“ “
“	“ “	1 east	25 ft west of C	“ “	“ “
“	“ “	2 east	“ “	“ “	“ “
“	“ “	3 east	“ “	“ “	“ “
“	“ “	4 east	“ “	“ “	“ “
“	“ “	5 east	“ “	“ “	“ “
“	“ “	6 east	“ “	“ “	“ “
“	“ “	7 east	“ “	“ “	“ “
“	“ “	8 east	47.28 ft west of C	“ “	“ “
“	Center	25 east	5.29 ft east of C	Stone mon	cross
“	“	26 east	West line	“	“
“	“	28 east	30.5 E of E line	“	“
“	20 ft S of C.	10 east	25 ft west of C	Granite mon	copperbolt
“	“ “	12 east	“ “	“ “	“ “
“	“ “	14 east	“ “	“ “	“ “
“	“ “	16 east	“ “	“ “	“ “

TABLE OF MONUMENTS—CONTINUED.

LOCATION.				DESCRIPTION.	
STREET.		AVENUE.		MATERIAL.	POINT.
Name.	Line.	Name.	Line.		
Superior	20 ft S of C	18 east	25 ft west of C	Granite mon	copper bolt
Third	Center	28west	East line	"	cross
"	"	16 "	"	"	"
"	"	15 "		Boulder	"
"	†100 ft south	12 "	Center line	Rock	"
"	† "	8 "	"	"	"
"	Center	19 east	East line	Granite mon	copper bolt
"	25 ft S of C	1 "	25 ft west of C	"	cross
"	"	3 "	"	"	"
"	"	5 "	"	"	"
"	"	7 "	"	"	"
"	"	15 "	"	"	"
"	"	1 west	"	"	"
"	"	3 "	"	"	"
"	"	5 "	"	"	"
"	25 ft S of C	23 "	25 ft west of C	Granite mon	cross
"	"	25 "	"	"	"
"	"	27 "	"	"	"
"	"	11 east	"	"	"
"	"	13 "	"	"	"
Thirteenth	Center	5 west	Near Center	Sandstone m	hole
"	"	19 east	East line	Granite mon	cross
"	"	16 west	"	"	"
Tenth	"	19 "	288 ft west of C	Stone mon	"
"	"	16 "	East line	Granite mon	"
"	†100 ft south	8 "	Center	Rock	"
"	Center	8 "	"	Sandstone	"
"	"	6 "	"	"	"
"	"	5 "	"	Granite mon	"
"	"	3 "	West of	Solid rock	"
"	North of	2 "	Center	Rock	"
"	†80 ft south	1 east	"	"	"
"	† 7 ft south	3 "	"	Ledge	"
"	Center	3 "	†20 ft west	Solid rock	"
"	"	19 "	East line	Granite mon	"
"	25 ft S of C	Lake	25 west of C	"	"
"	Center	24 west	Center	"	"
Twelfth	North line	17 "	East line	"	hole
"	Center	16 "	"	"	cross
"	Near	4 east	Center	Rock	"
"	Center	19 "	East line	Granite mon	"
"	†200 S of C	5th west	Center	Sandstone m	hole
Union	Center	Chestnut st	"	"	"
"	"	13 west	"	"	"
Victoria	South	Woodland	30 ft W of C	"	"
"	Near N line	"	30 ft E of C	"	"
"	Center	Essex	96 ft W of C	"	"
"	"	Cumberl'nd	Center	"	"
Walnut	South line	Cresent	Center	Stone mon	cross

NOTE—In 1891 the name of Bench street was changed to Superior street and Superior street east of Eighth avenue east was changed to London road. In above table the old names are used.

†In above table † indicates more or less.

SANITARY SEWERS.

TABLE No. 8.

Their Location, Size, Cost, Etc.

NOTE.—In this table when any sewer has been built in more than one block under one contract the rate per lineal foot has been prorated, irrespective of the size or varying quantities encountered.

Location.	From	To	Size in Inches.	Length.	Material.	Cost per Foot.	Total Cost.	Year Built.
Center street	Ohio avenue	Indiana avenue	9	507	Vitrified pipe	$1 15	$ 583 46	1891
First alley	60 ft E of Second ave W	Second avenue east	8	1,770	do	3 14	5.557 80	1887
First alley	360 ft E of Third ave W	Third avenue west	8	360	do	3 14	1,130 40	1887
First alley	Third avenue west	Fourth avenue west	12	467	do	3 14	1 466 38	1887
First alley	Fourth avenue west	Fifth avenue west	10	467	do	3 14	2,932 76	1887
First alley	Fifth avenue west	Sixth avenue west	9	467	do	3 14	1,969 36	1887
First alley	Sixth avenue west	Piedmont avenue east	8	624	do	3 14	533 80	1887
First alley	Second avenue east	Fourth avenue east	9	932	do	2 01	1,873 68	1889
First alley	Fourth avenue east	Sixth avenue east	8	879	do	2 01	1,767 15	1889
First alley	280 ft E of 18th ave west	Eighteenth avenue west	8	280	do	1 77	496 20	1890
First alley	Eighteenth avenue west	West line of 19th ave W	9	500	do	1 77	886 08	1890
First alley	Nineteenth avenue west	Twenty-first avenue west	12	812	do	1 77	1,438 92	1890
First alley	Twenty-first avenue west	Twenty-second ave west	10	417	do	1 77	738 93	1890
First alley	Fourteenth avenue east	New York avenue	10	476	do	1 47	709 09	1891
First alley	Ohio avenue	Oregon avenue	8	1,415	do	....	....	1891
First street	Fourteenth avenue east	Pennsylvania avenue	12	852	do	2 64	2,251 02	1888
First street	Pennsylvania avenue	Ohio avenue	10	955	do	2 64	2,522 94	1888
First street	Ohio avenue	Indiana avenue	12	466	do	2 64	1,231 24	1888
First street	Indiana avenue	Missouri avenue	9	466	do	2 64	1,231 24	1888
First street	Sixth avenue east	Eighth avenue east	8	880	do	1 96	1,730 12	1888
First street	Eighth avenue east	Ninth avenue east	9	472	do	1 96	927 78	1888
First street	Ninth avenue east	Tenth avenue east	8	416	do	1 96	818 02	1888
First street	Tenth avenue east	Eleventh avenue east	9	426	do	1 96	837 62	1888
First street	Eleventh avenue east	Thirteenth avenue east	8	815	do	1 96	1,602 72	1888
First street	First avenue east	Second avenue east	12	466	do	1 96	916 02	1888
First street	Second avenue east	Third avenue east	10	466	do	1 96	916 02	1888
First street	Third avenue east	Fifth avenue east	8	887	do	1 96	1,743 84	1888
First street	First avenue east	Third avenue west	8	1,864	do	1 96	3,664 08	1888
First street	Third avenue west	Fourth avenue west	12	466	do	1 96	916 02	1888
First street	Fourth avenue west	Fifth avenue west	10	466	do	1 96	916 02	1888
First street	Fifth avenue west	Sixth avenue west	9	466	do	1 96	916 02	1888
First street	Sixth avenue west	Eighth avenue west	8	875	do	1 96	1,720 37	1888
First street	Thirteenth avenue east	159 ft E of 13th ave	8	157	do	3 71	590 39	1891

First street	Missouri avenue	Montana avenue	8	891	Vitrified pipe.	1 60	1,426 34	1891
First street	Seventeenth avenue west	Eightenth avenue west	8	330	do	4 24	1,615 00	1891
First street	Eighteenth avenue west.	Ninteenth avenue west	12	532	do	4 24	2,259 48	1891
First street	Ninteenth avenue west	Twentieth avenue west	18	466	Vit. pipe in con	4 24	1,979 64	1891
First street	Twentieth avenue west	Twenty-first avenue west	1-1 x2-9	433	Brick	4 24	1,839 72	1891
First street	Twenty-first avenue west	Twenty-second ave west.	2- 2x3-3	507	“	4 24	2,153 47	1891
First avenue east	Superior street	Michigan street	2x3	162	“	4 01	650 27	1886
First avenue east	Across Michigan street		18	76	Vitrified pipe.	4 01	305 06	1886
First avenue east	Superior street	First street	18	371	do	5 75	2,133 62	1887
First avenue east	First street	Third alley	15	536	do	5 75	3,082 74	1887
First avenue east	Third alley	Third street	12	196	do	5 75	1,127 20	1887
First avenue east	Third street	Fourth alley	10	170	do	3 24	596 70	1887
First avenue east	Fourth alley	Fourth street	10	196	do	2 44	477 66	1887
First avenue west	Superior street	First alley	8	170	do	3 14	533 80	1887
First avenue west	First alley	First street	8	196	do	1 88	368 46	1887
First avenue west	Third street	Fourth street	8	366	do	3 46	1,265 20	1887
Fourth alley	Lake avenue	First avenue east	8	466	do	3 51	2,535 66	1887
Fourth alley	First avenue east	Second avenue east	10	466	do	3 51	2,535 66	1887
Fourth alley	Second avenue east	Third avenue east	9	466	do	3 51	2,535 66	1887
Fourth alley	Third avenue east	Fifth avenue east	8	935	do	3 51	5.071 32	1887
Fourth alley	Second avenue west	Fifth avenue west	8	1,705	do	2 07	3,525 99	1889
Fourth alley	Fifth avenue east	Eighth avenue east	8	1,398	do	2 59	3,620 70	1890
Fourth alley	Eighth avenue east	Ninth avenue east	9	466	do	2 59	1,206 90	1890
Fourth alley	Ninth avenue east	Tenth avenue east	12	474	do	2 59	1,227 60	1890
Fourth street	Lake avenue	Fourth avenue west	8	1,864	do	2 02	3,758 00	1887
Fourth street	Lake avenue	First avenue east	8	466	do	2 02	939 46	1887
Fourth street	First avenue east	Second avenue east	12	466	do	2 02	939 46	1887
Fourth street	Second avenue east	Third avenue east	9	466	do	2 02	939 46	1887
Fourth street	Third avenue east	Fifth avenue east	8	932	do	2 02	1,878 91	1887
Fourth street	Fifth avenue west	Sixth avenue west	8	581	do	1 75	1,014 16	1889
Fourth street	Fifth avenue east	Seventh avenue east	8	932	do	1 53	1,427 16	1890
Fourth street	Seventh avenue east	Eighth avenue east	8	466	do	1 49	696 76	1890
Fourth street	Eighth avenue east	Ninth avenue east	9	466	do	1 49	696 76	1890
Fourth street	Ninth avenue east	Tenth avenue east	12	475	do	1 49	710 17	1890
Fifth alley	Second avenue east	Third avenue east	8	413	do	1 13	467 21	1889
Fifth alley	Third avenue east	Fourth avenue east	10	498	do	1 13	563 39	1889
Fifth alley	First avenue west	Fourth avenue west	12	1,623	do	2 07	3,363 90	1891
Fifth alley	Lake avenue	First avenue west	9	442	do	2 07	916 11	1891
Fifth alley	Fourth avenue west	Fifth avenue west	8	340	do	2 07	704 81	1891
Fifth street	200 ft W of Second ave E	Third avenue east	8	733	do	1 61	1,183 37	1891
Fifth street	Third avenue east	Fifth avenue east	9	898	do	1 61	1,449 56	1891
Fifth street	Fifth avenue east	Sixth avenue east	8	446	do	1 61	719 89	1891
Fourteenth avenue east.	Lake Superior	First alley	24	1,426	do	2 64	3,767 25	1888
Fourteenth avenue east.	First alley	First street	20	254	Vit. pipe in con	2 64	671 21	1888
Fourteenth avenue east.	First street	Second alley	20	162	do	3 46	560 52	1891
Fourteenth avenue east.	Second alley	Second street	18	204	do	3 46	705 84	1891
Fourteenth avenue east.	Second street	Third street	18	363	do	1 93	693 40	1891
Jefferson street	Fourteenth ave east	New York avenue	12	449	Vetrified pipe.	2 96	1,333 22	1891

SANITARY SEWERS—CONTINUED.

Location.	From	To	Size in Inches.	Length	Material.	Cost per Foot.	Total Cost.	Year Built.
Jefferson street	New York avenue	Pennsylvania avenue	10	507	Vitrified pipe	$2 96	$1,501 91	1891
Jefferson street	Pennsylvania avenue	Maryland avenue	9	441	do	2 96	1,306 55	1891
Jefferson street	Maryland avenue	Ohio avenue	8	454	do	2 96	1,345 03	1891
Lake avenue	Fourth street	Fifth alley	8	144	do	2 07	298 34	1891
London road	Fourteenth avenue east	Fifteenth avenue east	8	413	do	3 11	1,288 03	1891
London road	Fifteenth avenue east	Seventeenth avenue east	9	911	do	3 11	2,841 61	1891
London road	Seventeenth avenue east	Eighteenth avenue east	12	475	do	3 11	1,481 45	1891
Maryland avenue	London road	South street	12	340	do	3 11	1,060 40	1891
Michigan street	Second avenue east	First avenue east	4-7	419	Cir. brick	10 16	4,257 46	1887
Michigan street	First avenue east	Second avenue west	3- 0x4-6	1,423	Brick	10 16	14,459 10	1887
Michigan street	Second avenue west	Third avenue west	2-10x4-3	467	do	10 16	4,655 19	1887
Michigan street	Third avenue west	Fourth avenue west	2- 3x3-4	457	do	10 16	4,643 58	1887
Michigan street	Fourth avenue west	Fifth avenue west	1- 6x2-3	471	do	10 16	4,785 83	1887
Michigan street	Fifth avenue west	Seventh avenue west	20	936	Vitrified pipe	10 16	9,420 70	1887
Michigan street	Piedmont avenue west	Fourteenth avenue west	10	283	do	7 95	2,250 98	1889
Michigan street	Fourteenth avenue west	Fifteenth avenue west	15	477	do	7 95	3,794 39	1889
Michigan street	Fifteenth avenue west	Garfield avenue	1- 6x2-3	462	Brick	7 95	3,675 14	1889
Michigan street	Garfield avenue	Seventeenth avenue west	1- 8x2-6	466	do	7 95	3,706 94	1889
Michigan street	Seventeenth avenue west	Eighteenth avenue west	2- 0x3-0	466	do	7 95	3,706 94	1889
Michigan street	Eighteenth avenue west	Nineteenth avenue west	2- 6x3-9	466	do	7 95	3 706 94	1889
Michigan street	Nineteenth avenue west	Twentieth avenue west	42 cir	466	do	7 95	3,706 94	1889
Michigan street	Twentieth avenue west	Twenty first avenue west	45 cir	466	do	7 95	3,706 94	1889
Michigan street	Twenty-first avenue west	Twenty-second ave west	48 cir	458	do	7 95	3,643 34	1889
Michigan street	Twenty-second ave west	Twenty-fourth ave west	1-10x2-9	912	do	7 95	7,254 33	1889
Nineteenth avenue west	Seventh avenue west	Eighth avenue west	10	510	Vitrified pipe	2 06	1,051 60	1889
Second alley	Superior street	Michigan street	20	260	do	3 75	976 63	1890
Second alley	Piedmont avenue east	Fifth avenue west	8	717	do	2 27	1,626 16	1887
Second alley	Fifth avenue west	Fourth avenue west	9	466	do	2 27	1,056 89	1887
Second alley	Fourth avenue west	Third avenue west	10	466	do	2 27	1,056 89	1887
Second alley	Third avenue west	Second avenue west	8	466	do	2 27	1,056 89	1887
Second alley	Second avenue west	Lake avenue	8	879	do	1 92	1,714 38	1888
Second alley	Lake avenue	First avenue east	8	413	do	1 92	1 806 31	1888
Second alley	First avenue east	Second avenue east	10	466	do	1 92	908 07	1888
Second alley	Second avenue east	Third avenue east	9	466	do	1 92	908 07	1888
Second alley	Third avenue east	Fifth avenue east	8	909	do	1 92	1,681 00	1888
Second alley	Eighteenth avenue west	Nineteenth avenue west	8	380	do	4 47	1,697 99	1891
Second alley	Nineteenth avenue west	Twentieth avenue west	9	499	do	4 47	2,229 87	1891
Second alley	Twentieth avenue west	Twenty-second ave west	12	947	do	4 47	4,232 39	1891
Second alley	Twenty-second ave west	Twenty-fifth ave west	2- 4x3-6	1,401	Brick	4 47	6,261 77	1891

Second alley	Twenty-fifth avenue west	Twenty-sixth ave west	2-2x3-3	425	Brick.	4 47	1,899 05	1891
Second alley	Twenty-sixth avenue W.	Twenty eighth ave west.	8	920	Virtified pipe	4 47	4,111 70	1891
Second alley	Ninth avenue east	Tenth avenue east	8	240	do	1 29	309 99	1890
Second alley	Tenth avenue east	Eleventh avenue east	12	470	do	1 29	607 08	1890
Second alley	Eleventh avenue east	Twelfth avenue east	9	466	do	1 29	601 92	1890
Second alley	Twelftn avenue east	Thirteenth avenue east	8	263	do	1 29	339 68	1890
Second alley	Fourteenth avenue east	Fifteenth avenue east	9	468	do	1 10	516 54	1890
Second street	Sixth avenue west	Fourth avenue west	8	884	do	2 84	2,514 10	1887
Second street	Fourth avenue west	Third avenue west	9	467	do	2 84	1,328 15	1887
Second street	Third avenue west	Lake avenue	8	1,402	do	2 84	3,987 29	1887
Second street	Fifth avenue east	Seventh avenue east	8	932	do	4 72	4,403 70	1888
Second street	First avenue east	Second avenue east	12	493	do	3 22	1,588 13	1888
Second street	Second avenue east	Third avenue east	10	466	do	3 22	1,501 19	1888
Second street	Third avenue east	Fourth avenue east	9	390	do	3 22	1,256 46	1888
Second street	Fourth avenue east	Fifth avenue east	8	456	do	3 22	1,468 99	1888
Second street	Ninth avenue east	Tenth avenue east	12	434	do	1 40	606 00	1888
Second street	Tenth avenue east	Eleventh avenue east	12	484	do	1 40	675 97	1888
Second street	Eleventh avenve east	Twelfth avenue east	10	466	do	1 40	650 80	1888
Second street	Twelfth avenue east	Thirteenth avenue east	9	466	do	1 40	650 80	1888
Second street	Seventh avenue east	Eighth avenue east	8	413	do	1 28	529 47	1890
Second street	Eighth avenue east	Ninth avenue east	10	522	do	1 28	669 21	1890
Second street	Sixth avenue west	Eighth avenue west	8	822	do	2 72	2,239 90	1890
Second street	Twenty-second avenue W	Twenty-fourth ave west	8	652	do	1 49	971 48	1891
Second street	Twenty-fourth avenue W	Twenty-fifth avenue west	8	413	do	1 49	615 37	1891
Second street	Twenty-fifth avenue west	Twenty-seventh ave west	9	950	do	1 49	1,378 86	1891
Second street	Twenty-seventh ave west	Twenty-eighth ave west	8	413	do	1 49	615 37	1891
Second street	Fourteenth avenue west	New York avenue	10	474	do	3 46	1,640 04	1891
Second street	New York avenue	Pennsylvania avenue	9	466	do	3 46	1,612 36	1891
Second street	Pennsylvania avenue	Ohio avenue	8	876	do	3 46	3,041 34	1891
Second avenue east	Superior street	First alley	9	166	do	2 01	333 72	1889
Second avenue west	Michigan street	First street	18	670	do	5 80	3,883 32	1887
Second avenue west	First street	Third alley	15	536	do	5 80	3,106 66	1887
Second avenue west	Third alley	Third street	12	197	do	5 80	1,141 81	1887
Second avenue west	Third street	Fourth street	9	366	do	2 78	1,019 07	1887
Seventh avenue east	First street	Second street	10	352	do	4 72	1,663 20	1887
Seventh avenue east	Second street	Third street	9	379	do	4 75	1,801 01	1887
Seventh avenue west	Second street	Third street	6	297	do	1 39	413 03	1891
Seventh & one-half alley	Second street	Third street	6	272	do	95	257 28	1890
Sixth avenue west	In Michigan street		15	36	Pipe in cor....	1 96	70 56	1890
Sixth avenue west	Michigan street	First alley	15	342	Vitrified pipe.	1 96	670 32	1890
Sixth avenue west	First alley	Third street	12	944	do	1 96	1,853 59	1890
Sixth avenue west	Third street	In Piedmont avenue east	15	110	do	1 96	215 60	1890
Sixth avenue west	Third street	Fourth street	9	348	do	1 96	682 08	1890
Sixth avenue west	In Fourth street	Piedmont avenue east	8	102	do	1 96	199 92	1890
Sixth avenue west	In Third street	Piedmont avenue east	8	114	do	1 96	223 44	1890
Sixth avenue east	Second street	Third alley	8	212	do	2 25	477 83	1890
Superior street	Eighth avenue west	175 ft east	9	175	do	4 01	702 45	1886
Superior street	175 ft E of 8th ave west	Seventh avenue west	10	134	do	4 01	537 88	1886

SANITARY SEWERS—CONTINUED.

Location.	From	To	Size in Inches.	Length.	Material.	Cost per Foot.	Total Cost.	Year Built.
Superior street	Seventh avenue west	Sixth avenue west	12	466	Vitrified pipe	$4 01	$1,870 52	1886
Superior street	Sixth avenue west	Fifth avenue west	15	466	do	4 01	1,870 52	1886
Superior street	Fifth avenue west	Fourth avenue west	18	464	do	4 01	1,862 50	1886
Superior street	Fourth avenue west	Third avenue west	2-3x1- 6	460	Brick	4 01	1,846 44	1886
Superior street	Third avenue west	First avenue east	2-9x1- 9	1,875	do	4 01	7,526 25	1886
Superior street	First avenue east	Eighth avenue east	2-9x1-10	3,275	do	4 01	13,145 85	1886
Superior street	Eighth avenue east	Ninth avenue east	21	467	Vitrified pipe	2 01	938 67	1886
Superior street	Ninth avenue east	Tenth avenue east	18	435	do	2 01	874 35	1886
Superior street	Tenth avenue east	Eleventh avenue east	15	497	do	2 01	998 97	1886
Superior street	Eleventh avenue east	Twelfth avenue east	12	468	do	2 01	944 68	1886
Superior street	Twelfth avenue east	Thirteenth avenue east	10	470	do	2 01	944 09	1886
Superior street	In 14th avenue on curve		10	38	Pipe in con.	1 99	75 67	1889
Superior street	Fourteenth avenue east	Fifteenth avenue east	9	419	Vitrified pipe	1 99	835 36	1889
Superior street	Fifteenth avenue east	Eighteenth avenue east	8	1,445	do	1 99	2,880 76	1889
Superior street	Eighteenth avenue east	Nineteenth avenue east	10	423	do	1 99	843 36	1889
Superior street	Nineteenth avenue east	Twentieth avenue east	9	462	do	1 99	921 03	1889
Superior street	Twentieth avenue east	Twenty-second ave east	8	893	do	1 99	1,779 76	1889
Superior street	Fourteenth avenue west	Sixteenth avenue west	8	861	do	3 75	3,233 87	1890
Superior street	Sixteenth avenue west	Piedmont avenue west	12	174	do	3 75	653 46	1890
Superior street	Piedmont avenue west	Eighteenth avenue west	15	720	do	3 75	2,704 32	1890
Superior street	Eighteenth avenue west	Nineteenth avenue west	18	466	do	3 75	1,750 22	1890
South street	Maryland avenue	Ohio avenue	20	450	Pipe in con.	3 11	1,403 38	1891
Tenth avenue east	Superior street	Second street	18	649	Vitrified pipe	3 13	2,033 57	1888
Tenth avenue east	Second street	Third street	15	366	do	3 13	1,146 68	1888
Tenth avenue east	Third street	Fourth alley	12	162	do	3 13	507 61	1888
Tenth avenue east	Fourth alley	Fourth street	9	203	do	3 13	635 94	1888
Third alley	Piedmont avenue east	Fourth avenue west	8	824	do	3 55	2,925 61	1887
Third alley	Fourth avenue west	Third avenue west	9	466	do	3 55	1,654 53	1887
Third alley	Third avenue west	Second avenue west	12	466	do	3 55	1,654 53	1887
Third alley	Second avenue west	Lake avenue	8	932	do	3 89	3,624 59	1887
Third alley	First avenue east	Second avenue east	12	466	do	3 07	1,432 00	1887
Third alley	Second avenue east	Third avenue east	10	466	do	3 04	1,417 68	1888
Third alley	Third avenue east	258 ft E of Third ave E	10	258	do	1 87	484 03	1888
Third alley	Tenth avenue east	Eleventh avenue east	10	474	do	98	464 87	1889
Third alley	Eleventh avenue east	Twelfth avenue east	9	466	do	98	457 03	1889
Third alley	Twelfth avenue east	Thirteenth avenue east	8	414	do	98	405 96	1889
Third alley	Fifth avenue east	Sixth avenue east	8	363	do	2 25	817 90	1890
Third street	Fifth avenue west	Fourth avenue west	8	467	do	4 24	1,979 61	1887
Third street	Fourth avenue west	Third avenue west	9	467	do	4 24	1,979 61	1887

Third street.............	Third avenue west.......	Second avenue west.....	10	467	Virtified pipe	4 24	1,979 61	1887
Third street......	Second avenue west......	First avenue west........	15	468	do	4 24	1,983 85	1887
Third street..	First avenue west........	Lake avenue............	8	467	do	4,24	1,979 61	1887
Third street....	Lake avenue.............	First avenue east	8	466	do	3 16	1,472 09	1887
Third street.............	First avenue east........	Second avenue east.. .	10	466	do	3 16	1,472 09	1887
Third street.............	Second avenue east......	Third avenue east.......	9	466	do	3 16	1,472 09	1887
Third street.............	Third avenue east........	200 ft E of Fifth ave east	8	1,164	do	3 16	3,677 08	1887
Third street.............	200 ft E of Fifth ave east	Seventh avenue east.....	8	700	do	4 75	3,326 40	1887
Third street.............	Tenth avenue east.......	Eleventh avenue east....	10	472	do	3 23	1,524 12	1890
Third street	Eleventh avenue east....	Twelfth avenue east.....	9	466	do	3 23	1,504 76	1890
Third street.............	Twelfth avenue east.....	Thirteenth avenue east..	8	470	do	3 23	1,517 67	1890
Third street.............	Fourteenth avenue east.	Pennsylvania avenue....	8	940	do	1 93	1,807 60	1891
Thirteenth avenue east..	Bench street.............	Within 37ft of First street	8	261	do	1 59	415 55	1890
Thirteenth avenue east..	37 ft of First street.......	First street..............	8	124	do	3 71	460 51	1891
Third avenue west.......	Michigan street.....	First alley.....	15	370	do	3 53	1,305 36	1887
Third avenue west.......	First alley........... ...	First street....	12	196	do	3 53	700 49	1887
Third avenue west.......	First street..............	Second street............	10	366	do	2 81	1,026 50	1887
Third avenue west.......	Third street..............	Fourth alley.............	8	170	do	2 07	351 90	1889
Twentieth avenue west..	Michigan street..........	First alley...............	18	485	Pipe in con.	1 77	859 64	1890
Twenty-sixth ave west ..	Second alley.............	Second street............	18	190	do	1 49	283 10	1891
Washington avenue......	Superior street......	First street.......	18	485	do	4 72	2,291 62	1887

STORM-WATER SEWERS.

TABLE No. 9.

Location.	From	To	Size in Inches.	Length.	Material.	Cost per Foot.	Total Cost.	Year Built.
First avenue west	St. P. & D. R. R.	First street	4-0	708	Brick.	$15 08	$10,676 71	1888
First avenue west	First street	Fourth street	3-8	1104	do	14 10	15,571 62	1888
First avenue west	Fourth street	Cascade square	3-4	560	do	12 72	7,123 43	1888
Seventh avenue west	Michigan street	Superior street	24	257	Vit. pipe in con	4 81	1,235 91	1888
Seventh avenue west	Superior street	First street	18	370	do	2 92	1,082 16	1888
Sixth avenue west	185 south Michigan street	Superior street	24	381	do	3 83	1,460 22	1888
Sixth avenue west	Superior street	First street	21	367	do	3 48	1,274 63	1888
Sixth avenue west	First street	Second street	21	368	do	3 85	1,417 50	1888
Sixth avenue west	Second street	Third street	18	372	do	3 98	1,476 90	1888
Sixth avenue west	Third street	Fourth street	15	373	do	5 47	2,041 30	1888
Fifth avenue west	St. P. & D. R. R.	Michigan street	24	231	do	3 65	843 44	1888
Fifth avenue west	Michigan street	Superior street	21	195	do	3 44	670 80	1888
Fifth avenue west	Superior street	First street	18	367	do	3 55	1,303 66	1888
Fifth avenue west	First street	Second street	18	369	do	2 86	1,056 72	1888
Fifth avenue west	Second street	Fifth street	15	1,110	do	2 89	3,211 20	1888
Fourth avenue west	15 ft south Mich. street	Superior street	24	260	do	4 94	1,284 40	1888
Fourth avenue west	Superior street	First street	21	367	do	3 46	1,270 04	1888
Third avenue west	Superior street	First street	24	367	do	4 20	1,541 87	1888
Third avenue west	Michigan street	Center Superior street	28	195	Concrete.	6 19	1,208 65	1888
Third avenue west	Center Superior street	North line Superior st	32	50	do	8 96	448 35	1888
Second avenue west	Superior street	First street	24	450	Vit. pipe in con	4 23	1,905 76	1888
Lake avenue	Michigan street	Superior stteet	15	229	do	3 39	777 48	1888
First avenue east	St. P. & D. R. R.	North line Michigan st.	32	81	Concrete.	8 19	663 40	1888
First avenue east	North line Mich. street	North line Superior st	28	195	do	6 01	1,173 27	1888
First avenue east	Superior street	First street	24	367	Vit. pipe in con	4 37	1,604 20	1888
First avenue east	First street	Third street	20	738	do	3 68	2,715 70	1888
First avenue east	Third street	Fourth street	12	348	do	3 60	1,245 84	1888
Second avenue east	Superior street	First street.	24	455	do	4 48	2,038 89	1888
Third avenue east	Across Superior street		28	89	Concrete.	7 54	670 80	1888
Third avenue east	Superior street	First street	24	367	Vit. pipe in con	3 93	1,444 51	1888
Washington avenue	Across Superior street		18	146	do	5 20	759 63	1888
Twenty-fourth ave west	Michigan street	Miller's creek	24	200	do	4 52	904 85	1888
Twenty-first avenue west	R. R. alley	First street	36	887	Brick.	5 97	5,302 91	1888
Twenty-first avenue west	First street	Third street	24	734	Vit. pipe in con	3 83	2,815 15	1888
Twenty-first avenue west	Third street	Fourth street	18	368	do	3 01	1,107 51	1888
Twenty-first avenue west	Fourth street	Fifth street	15	356	do	2 08	841 10	1888
Twentieth avenue west	R. R. alley	Superior street	36	511	Brick.	6 09	3,110 97	1888
Garfield avenue	R. R. alley	Michigan street	24	267	Vit. pipe in con	3 40	909 00	1888
Garfield avenue	Michigan street	Superior street	21	254	do	2 91	740 45	1888

Twelfth avenue west	Railroad alley	Superior street	6x8	229	Tunnel.	$26 08	$5,972 22	1888
Fifth street	Lake avenue	225 easterly	24	243	Vit. pipe in con	2 90	706 37	1889
Fifth street	First avenue west	Lake avenue	28	482	Concrete.	4 83	2,325 00	1889
Superior street	D. & I. R. R. R.	Tenth avenue east	36	397	do	6 44	2,556 43	1889
Nintcenth avenue west	Railroad alley	Michigan street	36	208	Brick.	4 42	919 30	1889
Ninteenth avenue west	Michigan street	Superior street	32	220	do	5 10	1,121 25	1889
Ninteenth avenue west	Superior street	First street	24	366	Vit. pipe in con	3 09	1,129 15	1889
Ninteenth avenue west	First street	Third street	18	760	do	2 97	2,257 65	1889
Seventeenth avenue west	Michigan street	Superior street	24	180	do	6 09	1,096 00	1889
Fifteenth avenue west	Across Michigan street		24	57	do	19 79	1,128 25	1889
Thirteenth avenue west	Across Michigan street		24	96	do	9 70	930 78	1889
Eleventh avenue west	Across Michigan street		24	104	do	9 22	959 65	1889
Eleventh avenue west	Piedmont avenue	First street	24	493	do	4 66	2,298 40	1889
Eleventh avenue west	Across First street		24	65	do	9 10	592 00	1889
Eighth avenue west	Michigan street	Superior street	24	228	do	4 28	976 67	1889
Tenth avenue west	Across Fifth street		24	64	do	5 75	368 05	1889
Sixth street	Across East Cascade st		15	77	do	1 71	132 03	1889
Third avenue east	First street	Fourth street	21	1,063	do	3 97	4,218 99	1889
Third avenue east	Fourth street	Fifth street	20	378	do	2 86	1,082 95	1889
Third avenue east	Fifth street	Sixth street	18	395	do	1 96	774 46	1889
Third avenue east	Sixth street	Seventh street	15	341	do	1 96	668 51	1889
Washington avenue	Superior street	123 ft northerly	18	123	do	2 95	362 85	1889
Washington avenue	123 ft north of Superior st	First street	12	320	do	2 39	764 50	1889
Second street	Seventh avenue east	Brewery creek	12	181	do	3 12	564 64	1889
Seventh avenue east	Third street	Fifth street	15	690	do	4 76	3,284 76	1889
Ninth avenue east	Across Fifth street		20	78	do	4 57	356 75	1889
New York avenue	Lake Superior	Superior street	24	532	do	3 30	1,759 50	1889
New York avenue	Superior street	Jefferson street	21	357	do	3 32	1,185 80	1889
New York avenue	Jefferson street	First street	20	617	do	3 06	1,893 50	1889
New York avenue	First street	Second street	18	366	do	2 30	841 90	1889
New York avenue	Second street	Fourth street	15	678	do	2 22	1,507 50	1889
New York avenue	Fourth street	Fifth street	12	334	do	2 26	757 00	1889
Maryland avenue	Across Superior street		26	75	Concrete.	6 00	450 00	1889
Maryland avenue	Across Superior street		24	52	Vit. pipe in con	5 97	310 85	1889
Ohio avenue	Across Superior street		26	86	Concrete.	12 07	1,037 99	1889
Indiana avenue	Across First street		24	72	Vit. pipe in con	4 89	352 40	1889
Oregon avenue	Across First street		24	72	do	4 42	318 60	1889
Pennsylvania avenue	Across Superior street		24	89	do	7 02	624 98	1890
Eleventh avenue west	Third street	Fourth street	26	1,175	Delta.	5 64	6,627 69	1890
Second street	Eleventh avenue west	Buckingham creek	15	183	V. pipe in sand	4 15	761 42	1890
Tenth avenue east	Superior street	Bench street	34	157	Concrete.	7 07	1,109 90	1890
Second avenue east	First street	Second street	20	332	Vit. pipe in con	3 62	1,201 55	1890
Second avenue east	Second street	Fourth street	18	736	do	3 57	2,631 80	1890
Second avenue east	Fourth street	Fifth street	15	370	do	4 15	1,537 00	1890
Twelfth avenue east	Superior street	Bench street	24	355	do	3 43	1,218 70	1890
Twelfth avenue east	Superior street	42 feet northerly	21	42	do	3 43	144 00	1890
Second avenue west	First street	Second street	24	336	do	6 70	2,250 92	1890
Second avenue west	Second street	Third street	20	370	do	7 04	2,605 26	1890

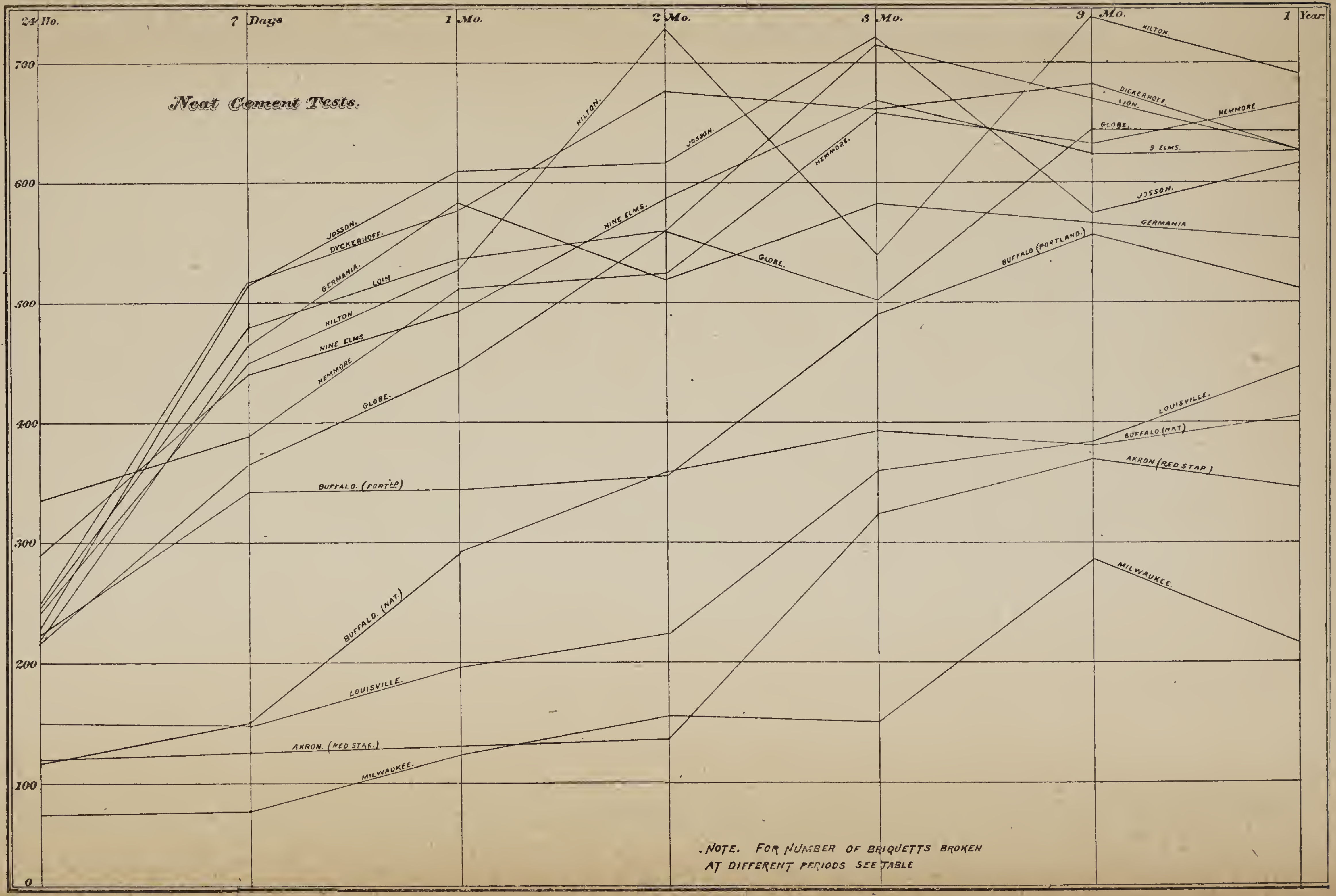
STORM-WATER SEWERS—CONTINUED.

Location.	From	To	Size in Inches.	Length	Material.	Cost per Foot.	Total Cost.	Year Built.
Second avenue west......	Third street.............	Fourth street............	18	370	Vit.pipe in con	$5 46	$2,021 60	1890
Second avenue west	Fourth street............	Fifth street....	15	372	do	4 41	1,642 70	1890
Fourth avenue west.....	First street..........	Second street............	18	336	do	5 61	1,887 03	1890
Fourth avenue west	Second street...	Fifth street........	15	1,112	do	5 75	6,394 97	1890
Third avenue west.......	First street..............	136 ft northerly.......	21	136	do	5 75	781 67	1890
Third avenue west.......	136 ft north of First street	Second street............	20	200	do	5 75	1,150 00	1890
Third avenue west.......	Second street.......... ..	Third street..............	18	370	do	7 01	2,594 63	1890
Third avenue west.......	Third street	Fifth street..............	15	742	do	6 29	4,665 67	1890
Twenty-fifth ave west...	Michigan street.....	Second street.....	26	905	Delta.	2 15	1,951 04	1891
Twenty-fifth ave west...	In Third street...........	To Miller's creek.........	15	170	V. pipe in sand	3 13	533 06	1891
Twenty-fifth ave west...	In Fourth street.........	To Miller's creek.........	15	14	do	26 07	364 96	1891
Twenty-fifth ave west...	In Fifth street...........	Miller's creek............	15	95	do	4 94	470 46	1891
Twenty-fifth ave west...	In Sixth street.	Miller's creek......	15	161	do	2 56	413 06	1891
Twenty-fifth ave west...	In Seventh street	Miller's creek.	15	90	do	4 85	436 96	1891
Ninth avenue east.......	First street..............	Fourth street....	36	1,242	Delta.	8 18	10,152 73	1891
Ninth avenue east......	Fourth street	Tenth street............ .	26	2,227	do	2 56	5,706 39	1891
Oregon avenue....... ...	Lake Superior...........	Jefferson street	32	1,298	do	6 36	8,263 34	1891
Oregon avenue...........	Jefferson street	Branch street	28	563	do	4 22	2,384 79	1891
Oregon avenue...........	Bench street.	First street ..., ...	28	328	do	3 91	1,284 52	1891
Oregon avenue..	First street..............	Fourth street............	26	1.102	do	3 60	3,972 85	1891
Pennsylvania avenue....	Lake Superior...........	Fourth street............	26	2,683	do	3 97	10,648 98	1891
Lake avenue.......	Fifth street	Piedmont avenue east....	26	1,119	do	5 57	6,243 16	1891
Twenty-third ave west...	Michigan street.........	Second street............	26	1,317	do	3 89	5,116 47	1891
Twenty-third ave west...	Sixth street......	Piedmont avenue west...	26	2,114	do	4 09	8,703 12	1891
Twenty-third ave west...	In Third street..........	....	15	36	Vitrified pipe.	5 05	333 36	1891

COMBINED SEWERS.

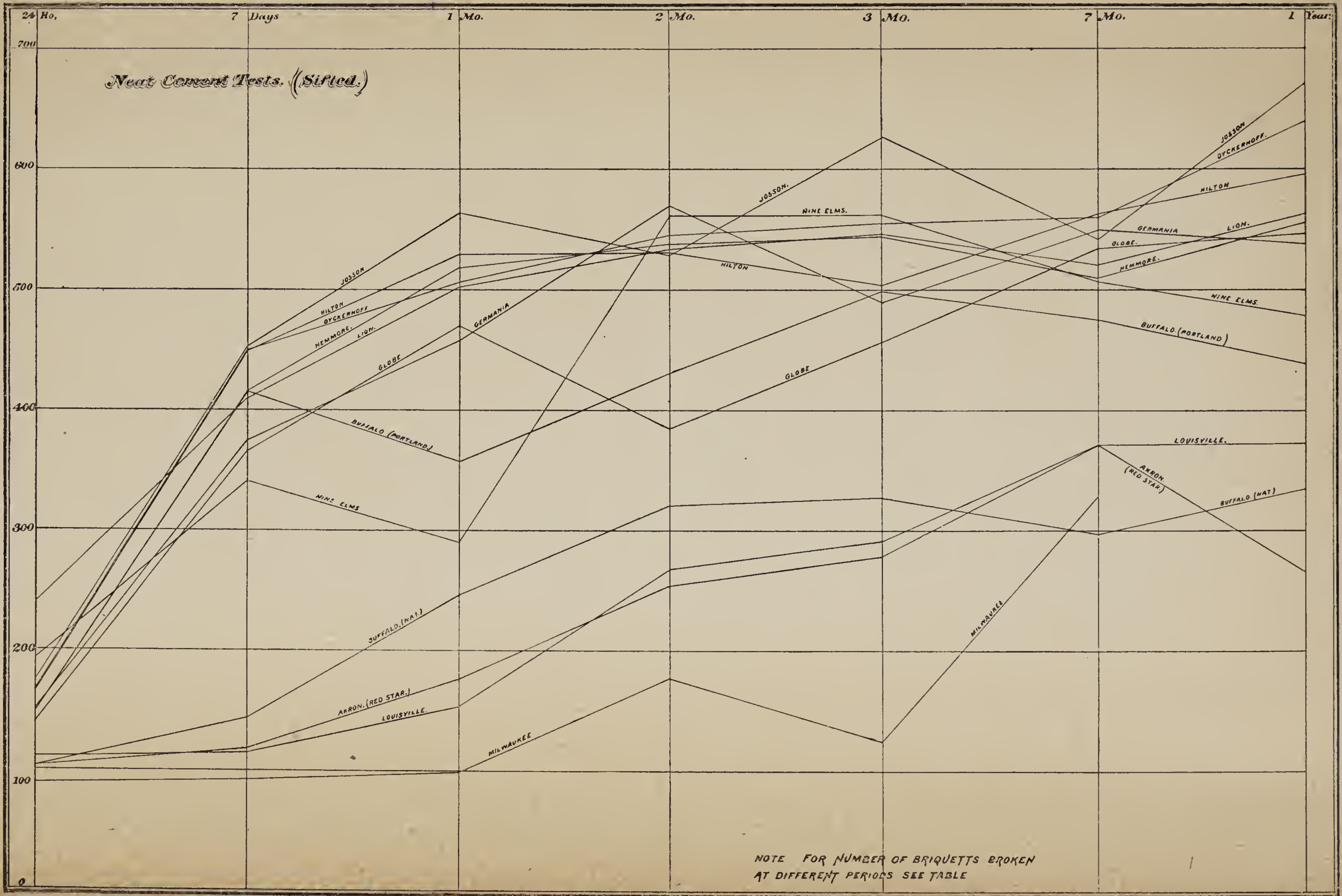
TABLE No. 10.

Location.	From	To	Size in Inches	Length.	Material.	Cost per foot.	Total Cost.	Year Built.
Ohio avenue	Lake Superior	South street	30	397	Concrete.	$ 5 20	$2,065 30	1890
Ohio avenue	South street	Superior street	26	295	do	2 86	844 35	1890
Ohio avenue	Superior street	Bench steet	24	882	Vit.pipe in con	4 29	3,789 90	1890
Ohio avenue	Bench street	Fourth street	21	1,465	do	3 11	4,551 80	1890
Ohio avenue	Fourth street	Fifth street	20	366	do	2 44	891 50	1891
Ohio avenue	Fifth street	Seventh street	18	734	do	4 34	3,185 60	1891
Second street	Seventeenth avenue west	Nineteenth avenue west	26	906	Delta.	4 17	3,777 99	1891
Second street	Nineteenth avenue west	Twentieth avenue west	30	503	Concrete.	5 63	2,835 39	1891
Second street	Twentieth avenue west	Twenty-first avenue west	40	468	do	6 29	2,947 28	1891
Second street	Twenty-first avenue west	Twenty-second ave west	44	337	do	10 42	3,513 91	1891
Twenty-second ave west	Michigan street	First street	5ftx7ft	487	Masonry.	24 81	12,085 54	1891
Twenty-second ave west	First street	Second street	4ftx6ft	574	do	9 24	5,305 07	1891
Twenty-third ave west	Third street	Sixth street	4ftx6ft	1,139	do	16 98	19,340 86	1891
Fourth avenue east	Superior street	Third street	28	1,065	Concrete.	6 74	7,183 60	1889
Fourth avenue east	Third street	Fifth street	24	700	Vit.pipe in con	3 92	2,744 00	1889
Fourth avenue east	In Fifth street.		21	27	do	3 97	107 35	1889
Fourth avenue east	Fifth street	Sixth street	18	405	do	1 93	781 60	1889
Fourth avenue east	Sixth street	Ninth street	15	1,066	do	2 12	2,257 90	18-9
Third avenue eas.t	Lake Superior	Superior street	3 ft 4 in	153	Brick.	12 18	1,863 00	1888
Superior street	Third avenue east	Fourth avenue east	3 ft 9 in	489	do	8 83	4,320 46	1888



Neat Cement Tests.

.NOTE. FOR NUMBER OF BRIQUETTS BROKEN AT DIFFERENT PERIODS SEE TABLE



Neat Cement Tests. (Sifted.)

NOTE FOR NUMBER OF BRIQUETTS BROKEN AT DIFFERENT PERIODS SEE TABLE

REPORT

—OF THE—

CITY ENGINEER

Estimating the Cost of a

NEW WATER SUPPLY SYSTEM.

City Engineer's Office.

DULUTH, MINN., March 31st, 1892.

To the Honorable The President and Common Council of the City of Duluth.

GENTLEMEN:

On December 3rd, last, I received from the City Clerk, notification of the passage by your honorable body, of the following resolution, viz:

> "Resolved by the City Council, that the City Engineer be, and he is hereby requested to investigate and report and furnish preliminary plans and estimates of a system of water works to supply the City of Duluth, as it will exits in 1895, particular attention to be given to the immediate needs of the people above Third Street."

In compliance with the requirements of this resolution I visited Grand Lake, Pike Lake and Cloquet River, as I was led to believe that a gravity supply might be drawn from either of these sources.

GRAND LAKE.

This lake is about 1,600 acres in area and 755 feet above Lake Superior; drainage area about 8,380 acres, including the lake; distance by road from the City Hall 16.3 miles and by air line 15.1 miles. The water is shallow over a great portion of the lake and the bottom is composed of a very soft, bad smelling, boggy material for several feet in depth. The water is slightly tinged yellow and does not appear pure or of desirable quality, Under the above circumstances this source of supply was not deemed worthy of further investigation.

PIKE LAKE.

Area 448 acres; height above Lake Superior 800 feet; distance from City Hall by road 11.6 miles and by air line 10.4 miles; drainage area 4,220 acres, including the lake. The water appeared to be clear and good, but when observed the quantitly running from the lake was not more than from one to two million gallons per day, by estimation.

Sufficient water from this source cannot be obtained and therefore no further investigation was made.

CLOQUET RIVER.

The point visited on this river was the crossing of the Vermillion Road about 19 miles from the City Hall by road, and 16½ miles by air line. At this place the river is about 764 feet above Lake Superior and the water is badly discolored. The drainage area is ample to yield sufficient water for the city for many years to come, but considering the distance and expense of drawing the water from this source, its discoloration and doubtful quality, I do not think that any scheme for its utilization would be likely to meet with public approbation.

It must be understood that the mileage, areas and levels given above are only approximate. The distances and areas have been taken from the best maps that could be obtained, and the elevations given are from barometrical observations.

There are no other sources within reasonable distance of the city whence a gravity water supply can be obtained, with the exception of Wild Rice Lake, but from the reports given me of its shallow and impure water and its low and boggy surroundings I did not consider it worth wasting time to visit.

There remain only two other sources of supply for investigation, viz: the sub-soil waters of Minnesota Point and Lake Superior.

SUB-SOIL WATERS MINNESOTA POINT.

That it is practicable to obtain a supply of pure water from this point I have little doubt, but there is some uncertainty as to the extent of the works that would be necessary in order to procure a large daily yield, owing to the fineness of the filtering material and the absence of any tests, so far as I know, of its rate of filteration.

There are a number of towns in the New England states and elsewhere which draw their supplies from the ground either by means of large wells, filter galleries, filter basins or tubular wells sunk in the low lands adjacent to some stream, lake or pond in or near the vicinity.

Some of these supplies are satisfactory and some are not, while others have proved utter failures.

It cannot be concluded that because a certain plan has proved successfull in one place, it may therefore safely be applied in some other locality similarly situated. Neither would it be correct or wise to act upon the opposite contention. Each locality has its own peculiarities which must be carefully studied before an opinion could be formed as to what ought to be done and what results would be likely to follow.

In this particular case it is necessary to conduct a series of experiments and tests in order to determine how much water could be relied upon from some definite area and to what extent a given or known draft would lower the water. The difficulty is that with a heavy and increasing draft of water, after the lapse of time, with filter basins and galleries, the filtering material is apt to silt up and become clogged so as to render enormous extensions necessary or a resort to some other means of increasing the supply. Some cities have experienced this and in order to meet the daily demand have had to introduce contaminated water directly into their filter basins from the nearest availabe source.

It will be remembered that the question was raised in the City Council some months ago as to the contemplated expenditure in sinking test wells on Minnesota Point, for the purposes of this investigation but that owing to the opposition that was then raised, the original resolution authorizing that expenditure was amended by striking out the authorization.

I have therefore not felt at liberty to incur any expense in that direction and consequently am not in a position to recommend that source of supply.

My opionion, however, is that even if it could be shown by experiment and tests to be perfectly feasable, and that a saving might be effected by its present adoption, public sentiment would not favor the scheme while an abundant supply of undoubtedly pure water is available from Lake Superior for all time, no matter what size the city may ultimately attain.

LAKE SUPERIOR.

After considering all the available sources, as above outlined, I have to recommend the adoption of a pumping system, from this lake, on an adequate scale for all probable requirements for the next ten or fifteen years or more.

I would suggest drawing the water from some convenient point on the north shore remote from the present contamination by sewage and likely to remain so for a long time, but not so far removed as to render the undertaking unnecessarily burdensome to the tax payers, while in case of the rapid growth of the city in that direction, the intake pipe might be capable of further extension into pure water; or the main might be extended farther northwardly along the shore when the proper time arrives to consider these questions.

Apparently such a point may be found at or about the foot of avenue A, Lakeside, three quarters of a mile below the mouth of Lester river and six and a half miles from the City Hall. I have indicated a suitable location for the pumping works in this locality on the accompanying plan showing the proposed mains, reservoirs, etc.

During the summer and latterly since the lake has been frozen in this vicinity, observations have been taken at various times with the view to determine the nature and velocity of the lake currents and to what extent danger from them was to be apprehended in any scheme for a new water works supply.

With this object in view a number of sheet iron floats was placed at different times in various suitable positions along the north shore of the lake from the present water works intake to a point about a mile east of Lester river. These floats were sunk to uniform depths of 10, 20 and 40 feet and their position recorded when placed in the water.

Shortly after the first series of floats was started, a strong breeze from the south west sprang up which carried them along with it in a direction nearly parallel to the shore.

It is to be regretted that during the following night some large rafts of logs were towed to the city directly over the course taken by the floats so that the buoys to which they were secured were destroyed and sunk. Most of the apparatus was thus lost before any result could be obtained.

Subsequent observations, however, as far as they go, tend to show that there are no regular currents along the north shore where these floats were immersed. The floats and attached buoys invariably followed the direction of the winds or nearly so and unfortunately no period of continuous calm weather was available within which to make any examination.

The observations made through the ice confirm the conclusion that there is no continuous perceptible current in any one direction, anywhere near the shore within the limits above defined.

From observations taken for many years by the army engineer corps, it appears that the extreme rise and fall of the lake at long intervals apart. in this vicinity is about three feet. That is, the water—by the action of prevailing winds and other causes—has been known to fall as low as one foot below the city datum, while at other times it has risen as much as two feet above the same datum. City datum, I understand, having been taken as the average level of the water in the harbor near the canal during the winter of 1873 and is the same as the datum established and used by the Government Engineers.

It seems probable to me, from my limited observations, that whatever currents there may be at the head of the lake are variable and are dependent upon three things, viz:

1st, the wind; 2nd, the state or height of the water at the time, and 3rd, the volume of flow in the St. Louis and other rivers discharging into the bay.

To be of value, any observation undertaken for the more accurate determination of these currents would have to be continuous for a long period of time and would necessarily involve very considerable expense. Simultaneous observations should also be made at other localities around the lake for the purpose of comparison.

The general plan accompanying this report shows the city to be divided into three water service districts.

The low level district is intended to embrace all sections of the city up to about 180 feet above the lake.

The middle service district embraces all sections above the low level and up to about 420 feet above the lake.

The high level district is intended to be supplied for the present by direct pressure, without the intervention of any reservoir, and to furnish water above the middle district.

It has been found impracticeable to adopt any of the usual formulas in determining the sizes of the principal mains because it is not now possible to predict what the rate of increase in population is likely to be within the different districts under consideration.

While I believe that a 30-inch low service force main would be ample for several years—yet, as the general impression is that the city will probably continue to increase as rapidly, or perhaps in a still higher ratio than it has within the past few years, and as large quantities of water may be needed for manufacturing purposes, besides which new additions and districts must be provided for, it would appear judicious to anticipate a larger consumption than the circumstances otherwise would seem to warrant.

I may say while I know many cities where the mains and works have been designed on too small a scale, I have never yet heard of one where a mistake has been made in the other direction.

For the above reasons I have provided for a 36-inch low service force main from the main pumping station at Lakeside to the low service reservoir at New York avenue (a distance of 6 miles); a 24-inch main for the middle district up to the proposed reservoir at Fourteenth street and an 18-inch main for the high level district. No portion of the latter main, however, needs to be laid at present, as one of the smaller pipes may be utilized—as shown on the plan—until the demand is sufficient to warrant further expenditure.

The following schedule shows the location of the mains and pipes for which provision has been made.

TABLE OF MAINS AND PIPES PROVIDED FOR IN THE ESTIMATE.

LOW SERVICE DISTRICT.

Street.	From	To	Size in Inches.	Length in Feet.
Avenue "A"	Pump house	Grand avenue	36	720.0
Grand avenue	Avenue "A"	East avenue	36	7,473.6
Summit avenue	East avenue	Fahnstock avenue	36	1,398.0
Superior street	Fahnstock avenue	Oregon avenue	36	17,139.6
Oregon avenue	Superior street	Second street	36	736.8
Second street	Oregon avenue	Pennsylvania avenue	36	2,330.4
Pennsylvania avenue	Second street	Res. "B"	36	1,759.2
Total				31,557.6

MIDDLE SERVICE DISTRICT.

Seventh street	Fifteenth avenue east	Fourth avenue east	24	5,126.4
Fifteenth avenue E.	Pump house	Seventh street.	30	500.4
Seventh street	Fourth avenue east	Piedmont ave east	18	2,208.0
Fourth avenue east	Seventh street	Res. "C"	24	2,821.2
Fifth street	Seventh avenue east	Twelfth avenue east	6	2,330 4
Sixth street	Cascade east	Twelfth avenue east	6	5 796.0
Eighth street	Lake avenue	Fifth avenue east	6	2,334.0
Ninth street	Second avenue west	Fifth avenue east	6	3,264.0
Tenth street	Fourth avenue east	Seventh avenue east	6	1,398.0
Eleventh street	Fourth avenue east	Sixth avenue east	6	934.2
Twelfth avenue east	Fifth street	Seventh street	8	732.0
Total				27,444.6

HIGH SERVICE DISTRICT.

Street.	From	To	Size in Inches.	Length.
Piedmont avenue east	Fourth avenue east..	Tenth street..........	8	1,434.0
Tenth Street... ...	Piedmont avenue east	First avenue west....	8	1,236.0
Boulevard	First avenue west....	Twelfth avenue west	8	5,721.6
Sixth street	Sixth avenue west....	Twelfth avenue west	6	2,796.0
Eighth street..... ...	Eighth avenue west .	Eleventh avenue west	6	1,398.0
Eighth avenue west..	Sixth street.	Tenth street....	8	1,464.0
Beacon avenue.......	Tenth street..........	Ariel street...........	8	424.8
Fourth avenue east..	Thirteenth street....	Res. "C".............	24	624.0
Total............	....	....	. ....	15,098.4

SUMMARY.

36 inch pipe	31,557	lineal	feet
30 " "	500	"	"
24 " "	8,571	"	"
8 " "	11,013	"	"
6 " "	20,251	"	"
18 " "	2,208	"	"
Grand total	74,100	"	"

The intake is designed to be 42 inches in diameter extended into 50 feet of water, or about 950 feet in length. A smaller pipe would answer all present purposes, but it was deemed advisable to make it proportional to the principal rising main in view of future requirements.

Provision has been made in the estimates for pumping machinery of high duty and of ample capacity for several years to come, assuming that the population will increase at a rapid rate. While the engines are large they are not capable of taxing the mains to their full capacity, but as time advances and the the demand for more water arises, duplicate pumps may be added or machinery of greater capacity may be substituted with beneficial effects. In fact before the lapse of many years, it will probably be found advisable to provide duplicate or auxiliary engines as a simple matter of precaution and the engine houses should be so constructed in the first instance as to admit of this being readily and cheaply done.

Some difficulty has been experienced in selecting suitable sites for the proposed reservoirs, and while it is by no means necessary to adhere to the localities shown on the plan I believe them to be as favorable, all things considered, as any that can be found.

The capacity of the new low service reservoir (4,000,000 gallons) is much less than I would like to have it, but there appeared so many advantages in placing it along side of the Water Company's present reservoir that they seem to me to outweigh other considerations, and when the works are combined as they should be and probably will be at some time, the united capacity of these reservoirs (about 8,000,000 gallons), though less than appears desirable, will no doubt be sufficient for a long time.

The middle service reservoir is designed to have a capacity of 5,625,000 gallons and the high service pumps will be supplied directly from it.

In designing this new system of water works it has been assumed that the existing mains and pipes of the present Water Company will ultimately be amalgamated into the general plan, but there is nothing to hinder the undertaking from being carried out independently of any such consideration if it is deemed desirable, though no new pipes have been laid out in any portion of the district now supplied by the company.

In regard to giving "particular attention to the immediate needs of the people above Third street," the provision made and shown on the plan for the middle service district will, I trust, meet the case. I have communicated with the manager of the Water Company with the view to ascertaining if the company will supply a limited quantity of water from the present reservoir for that purpose. The matter, I understand, has been referred to the directors who have not yet sent me their decision.

If the supply can be taken, pro tem, from that source and the work of construction is undertaken without any delay, there is no reason why the people residing above Third and Fourth streets should not reap the benefits this autum.

Regarding your requirements for a system of water works to supply the city "as it will exist in 1895," I may say that I understand Lakeside is to be annexed in 1893, West Duluth in

'94, and New Duluth and Fond du Lac in '95. The city will then comprise a territory extending along the lake, bays and River St. Louis for a distance of twenty-seven or twenty-eight miles.

There will be no difficulty in meeting the demands of the city proper, Lakeside and West Duluth under the plan proposed, providing the existing water works are acquired by the city, otherwise duplicate mains not shown on the plan will have to be laid, but in any case extensions will be needed beyond the limits of the plan to meet the demands of New Duluth and Fond du Lac when they arise, and the distance is so great that it is probable an intervening reservoir may be found both advisable and requisite.

Referring to the high level system, I may say that it has been designed more to show what can be accomplished in that direction and to meet the reqirements of the petition from the Syndicate Improvement Company, presented to the city council last summer, than from any immediate requirment so far as present householders are concerned, as there are only about half a dozen houses now within the limits of the pipe lines laid down on the plan.

The following is the estimated cost of the works:

ESTIMATE OF COST OF CONSTRUCTION.

LOW LEVEL SYSTEM.

(No Distribution Pipes Included.)

REAL ESTATE:		
4 lots east of Avenue A and south of London avenue (400 ft.) at $1,000	$ 4,000 00	
8-50 100 lots south of D. & I. R. R. R. and west of Avenue A at $275	2,200 00	
Lots 5 to 12 inclusive, block 105, Endion division (Reservoir B)	9,800 00	
		$ 16,000 00

INTAKE (42-inch :		
190 tons cast iron at $30	$ 5,700 00	
10 tons special castings at $60	600 00	
6,800 lbs lead at 5 cents	340 00	
Yarn	25 00	
286 cu. yds. rock excavation at $8	3,288 00	
950 ft. laying at $20	19,000 00	
Intake well	2,000 00	
		29 953 00
PUMPING PLANT:		
Engine and boiler house, coal shed, etc	$ 20,000 00	
Pumping Engine and boilers (10 million)	72,200 00	
		92,200 00
Coal switch (1,100 feet)		6,760 00
MAINS:		
6,876 tons cast iron at $30	$206,280 00	
192 tons special castings at $60	11,520 00	
200,000 lbs lead at 5 cents	10,000 00	
Yarn	740 00	
34,450 cu. yds earth, excavated at 50 cents	17,225 00	
16,380 cu. yds. rock, excavated at $5	81,900 00	
20,000 ft. b. m. timber at $20	400 00	
4 36-inch gate valves at $550	2,200 00	
Laying 31,560 lin. ft. 36-inch pipe at 20 cents	6,312 00	
Replacing 700 sq. yds. paving at $1	700 00	
		337,277 00
Reservoir B		36,174 00
		$518,364 00
Add ten per cent. for incidentals, engineering and inspection		51,836 00
Total		$570,200 00

ESTIMATE OF COST OF CONSTRUCTION.

MIDDLE SYSTEM.

REAL ESTATE:		
Lots 1 to 8, inclusive, block 99, Endion dvision	$12,000 00	
Lots 49 to 64, inclusive, block 198, Third division, (Reservoir C)	10,000 00	
		$22,000 00

Pumping Plant:		
Engine and boiler house, coal sheds, etc	$15,000 00	
3 m. pumping engine and boilers	25,500 00	
		40,500 00
Mains:		
15,300 cu. yds. earth, excavated at 50 cents	$ 7,650 00	
11,390 cu. yds. rock, excavated at $5	56,950 00	
1,520 tons cast iron at $30	45,600 00	
21 tons special castings at $60	1,260 00	
48,000 ℔s lead at 5 cents	2,400 00	
Yarn	150 00	
Laying	1,765 00	
1 30-inch gate at $425	425 00	
3 24-inch gates at $250	750 00	
1 18-inch gate at $100	100 00	
1 8-inch gate at $25	25 00	
10 6-inch gates at $15	150 00	
45,000 ft. b. m. timber at $20	900 00	
		118,125 00
Reservoir C		31,430 00
		212,075 00
Add ten per cent. for incidental, engineering and inspection		21,207 00
Total		$233,282 00

ESTIMATE OF COST OF CONSTRUCTION.

HIGH LEVEL SYSTEM.

Real Estate,		
Lots 57, 58, 59, 60, 62 and 64, block 185, Third division	$ 3,000 00	$ 3,000 00
Pumping Plant:		
Engine and boiler house, coal sheds etc	10,000 00	
1 m. pumping engine and boilers	11,200 00	
		$21,200 00
Mains:		
7,806 cu. yds. earth excavated at 50 cents	$ 3,903 00	
5,816 cu. yds. rock, excavated at $5	29,080 00	
390 tons cast iron at $30	11,700 00	
5 tons special castings at $60	300 00	
12,700 ℔s lead at 5 cents	635 00	
Yarn	60 00	
Laying	562 00	
2 8-inch gates at $25	50 00	

3 6-inch gates at $15	45 00	
		46,335 00
		$70,535 00
Add ten per cent. for incidentals, engineering and inspection		7,053 00
Total		$77,588 00

HYDRANTS (3 systems):

20 at $100 each	$2,000 00
10, including gates, at $125	1,250 00
Total	$3,250 00

SUMMARY.

Lower system	$570,200 00
Middle system	233,282 00
Upper system	77,588 00
Hydrants	3,250 00
Grand total	$884,320 00

Respectfully submitted,

E. H. KEATING,
City Engineer.

Appended will be found a list of the plans it has been found necessary to prepare.

LIST OF PLANS AND PROFILES MADE FOR THE PURPOSE OF PREPARING AN APPROXIMATE ESTIMATE OF A SYSTEM OF WATER WORKS.

1. Profile of main pipe line from pump house at Avenue A to Grand avenue and westward along Grand avenue to West avenue, thence along Summit avenue to Superior street and along Superior street to West avenue.

2. Profile of main pipe line—being a continuation of the above along Superior street (formerly Bench street) to Oregon avenue; along Oregon avenue to Second street; along Second street to Pennsylvania avenue; along Pennsylvania avenue to reservoir B.

3. Contour map showing the nature of the bottom of the lake in the vicinity of avenue A.

4. Contour map in block 105, Endion division, showing reservoirs A and B.

5. Contour map of blocks 185, 191 and 198, Third division, showing reservoir C.

6. Plan of city, showing present system in connection with the systems designed.

7. Section, showing designs for reservoirs B and C.

8. Detail, showing arrangement of pipes at pumping station for middle system.

9. Detail showing timber trestle for main pipe line.

10. Plan showing direction of lake currents.

PLANS AND SPECIFICATIONS

—SUBMITTED BY—

F. C. H. ARENTZ and L. E. SANGDAHL,

—FOR A—

Bridge Across the Ship Canal.

Plans and Specifications for Bridging Canal.

MILWAUKEE, WIS.,
December 28, 1891.

To the Honorable Board of Public Works, Duluth, Minn.

GENTLEMEN:—We hereby respectfully submit plans and specifications for a proposed draw-bridge across the Ship canal at Duluth, Minn., according to your "Notice" and "Guidance for Competitors," of November 12, 1891.

Of the different ways of moving a large and heavy body with quickness, safety and reliance the one by cable is, in our opinion, the most feasible one, employing material of superior strength, as are wire cables, and getting the benefit of the smoothness of action offered by this system of transportation.

The bridge will be moved by six 1½ inch wire ropes, arranged in pairs, running over equalizing sheaves fastened to the bridge and wound on grooved drums operated by machinery—plant located on one side of the bridge near the south end. The whole structure will be carried on a nest of twelve trucks, arranged under the tower of the bridge, and traveling on a firm track.

The bridge will have end lifts to take up the deflection, and also strong automatic latch-hooks and air cushions at the north end.

The bridge can be lowered or raised in fifteen seconds, and rolled back to clear the full width of the canal (250 ft.) in one minute.

In order to make the machinery as simple as possible and to keep down as much as possible the damage to property, we have arranged it so that all tracks curve off from the shore-arm and connect with tracks approaching the sides, thus leaving unobstructed the track in front of the bridge on which it runs when being opened and closed. This track will be enclosed by a substantial railing.

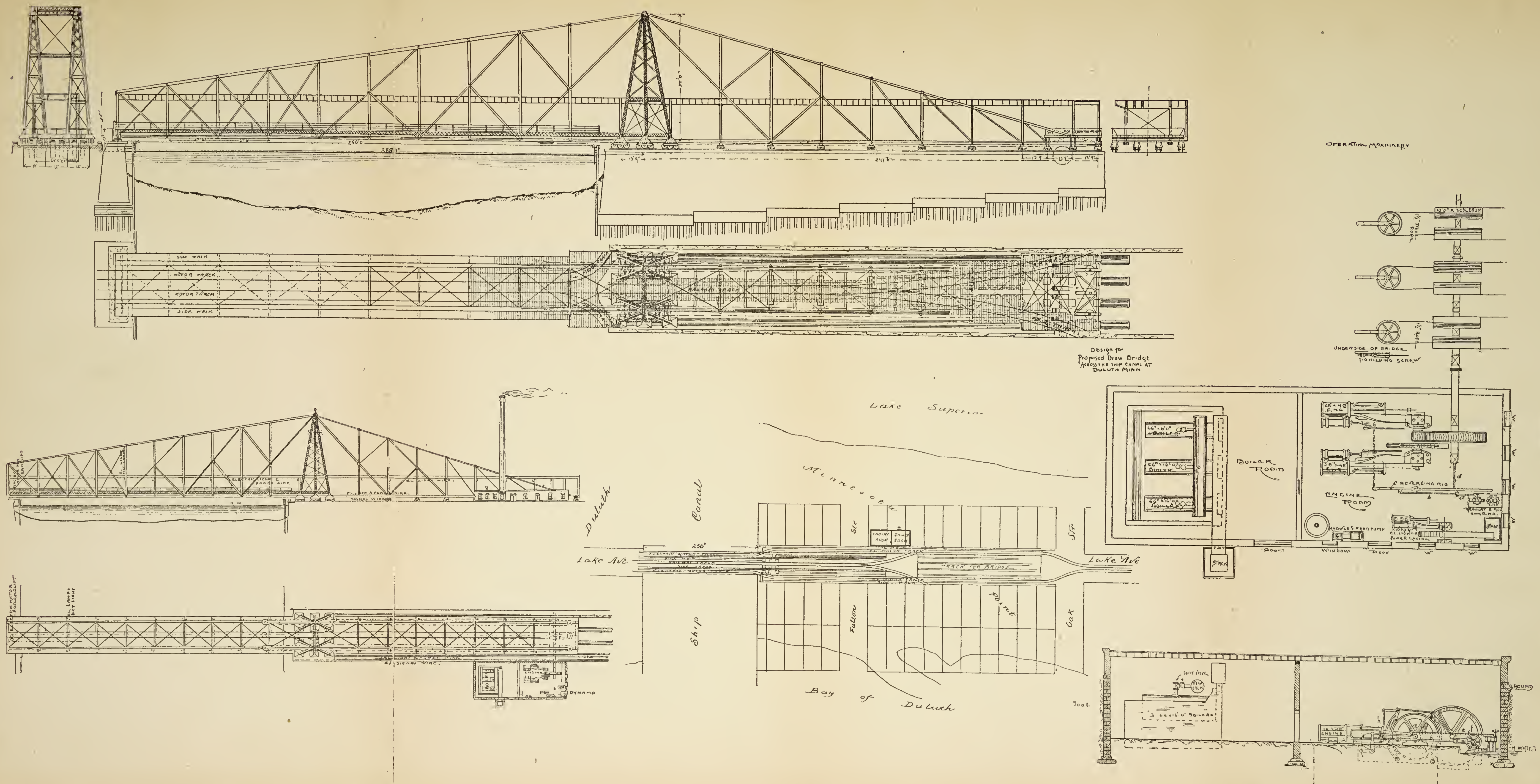
There will be electric signal lights and electric illumination of the bridge throughout.

As an approximate cost of the whole structure complete we beg leave to name: For sand stone in the foundations, $236,000; for St. Cloud granite in the foundations, $350,000.

This structure may be completed in the neighborhood of nine months after the approval of the plans.

Respectfully submitted,

F. C. H. ARENTZ,
L. E. SANGDAHL.



Design for
Proposed Draw Bridge
Across the Ship Canal at
Duluth Minn.

IN THE SENATE OF THE UNITED STATES.

LETTER

FROM THE

SECRETARY OF WAR,

IN RESPONSE TO

Senate Resolution of April 12, 1892, Relative to the Proceedings of the Board of Officers Convened to Consider the Construction of a Bridge in Duluth.

APRIL 18, 1892.—Referred to the Committee on Commerce and ordered to be printed.

Letter from the Secretary of War,

IN RESPONSE TO

Senate Resolution of April 12, 1892, Relative to the Proceedings of the Board of Officers Convened to Consider the Construction of a Bridge in Duluth.

War Department,
Washington, April 15, 1892.

Sir:—I have the honor to transmit a letter from the Chief of Engineers, dated the 14th instant, and its accompanying copy of a report, dated April 6, with the inclosures, from the Board of Engineers recently convened to examine and report upon the plans of a bridge over the entrance to Duluth Harbor on Lake street, Duluth, Minn., which papers are furnished in response to the following resolution of the Senate, dated April 12, 1892:

Resolved: That the Secretary of War is hereby directed to transmit to the Senate a copy of the report of and the proceedings before the Board of Engineer Officers convened for the purpose of considering and determining as to the construction of a bridge across the canal through Minnesota Point, in the city of Duluth. Very respectfully,

S. B. ELKINS,
Secretary of War.

The President of the United States Senate.

Office of the Chief of Engineers, U. S. Army,
Washington, D. C., April 14, 1892.

Sir:—I have the honor to acknowledge receipt of resolution of the Senate of the United States of the 12th instant, directing the Secretary of War "to transmit to the Senate a copy of the report of and the proceedings before the Board of Engineer Officers convened for the purpose of considering and determining as to the construction of a bridge across the canal through Minnesota Point, in the City of Duluth."

In reply to the reference of the resolution to this office I have the honor to submit the accompanying copy of report of April 6, and its inclosures, by the Board of Engineers recently convened to examine and report upon the plans of a bridge over the entrance to Duluth Harbor, on Lake street, Duluth, Minn., submitted by the Board of Public Works of the city of Duluth, Minn.

The resolution of the Senate is herewith returned.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen. Chief of Engineers.

HON. S. B. ELKINS,
Secretary of War.

REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., April 6, 1892.

GENERAL:—By Special Orders No. 6, Headquarters Corps of Engineers, February 1, 1892, a Board of Engineers was constituted to assemble at Detroit, Mich., upon the call of senior member, "to examine and report upon the plans of a bridge over the entrance to Duluth Harbor, on Lake street, submitted by the Board of Public Works of the City of Duluth, Minn."

Under date of February 1, 1892, the Board were instructed to give careful consideration, to the subject, and to advertise for twenty days in two daily papers (six insertions in each paper), published in each of the cities of Buffalo, N. Y.; Cleveland, Ohio; Detroit, Mich.; Chicago, Ill., and Milwaukee, Wis., the fact that a hearing will be had upon a proposed bridge over the canal at Duluth; the day of meeting of the Board to be announced in the advertisement.

Under date of February 29, 1892, the Board were further instructed: "That it was not intended that the duties of the Board should be limited to the consideration of the plans submitted by the Board of Public Works of the City of Duluth, Minn., alone, but that the Board should consider and report upon the advisability of permitting the construction of any bridge over the harbor entrance."

In obedience to the instructions first cited, the following advertisement was published as directed:

UNITED STATES ENGINEER OFFICE,
Duluth, Minn.

Application has been made to the Secretary of War by the municipal authorities of the city of Duluth, Minn., for permission to bridge the canal at the entrance of the harbor at that place, and a public meeting to consider such arguments as may be advanced for and against granting the permission sought, will be held at the United States Engineer office, 34 West Congress street, Detroit, Mich., beginning at 10 a. m., March 21, 1892. All persons interested are invited to be present, and an opportunity will be given to all who desire to be heard. It is requested that arguments be reduced to writing and presented in duplicate, either in person or by mail.

W. L. FISK,
Captain, Corps of Engineers.

The Board assembled accordingly at the United States Engineer office, 34 West Congress street, Detroit, Mich., at 10 a. m., March 21, 1892, and devoted the remainder of that day and the whole of the two days next succeeding to a public hearing of all parties desiring to present their views upon the subject, at the same time encouraging such opposition to each speaker as would tend to elicit all the facts and theories relating to the case. Every endeavor was made, both by the advertisement and during the course of the public sessions of the Board, to secure proper presentation of the arguments for and against the proposition to bridge the canal in question, and it is believed that this was accomplished to the satisfactionn of all concerned, and that all desiring to do so had the fullest opportunity to be heard and to controvert opposing views.

The substance of the oral discussion, especially those presented by the persons favoring the bridge, was reduced to writing, and this, with all written briefs in the case, is transmitted with this report. It is to be regretted that the oral arguments made in the interest of those opposing the bridge were not stenographically reported, to the end that they might be referred to at any time.

The following is a summary of arguments submitted by those who favored the construction of the proposed bridge, viz:

The people of Duluth are interested to a greater degree than anybody else in having an unobstructed harbor entrance, and therefore do not desire to do anything which would be likely to injuriously affect it. The territory of Minnesota Point is imperatively necessary to the city for business purposes. Manufacturing, wharfage and railroad terminal facilities thereon can only be utilized through a ready means of communication: and, for these, under present conditions, none but a bridge is practicable. An enormously valuable property is rendered useless through this lack of suitable communication with the mainland.

It is asserted that railrords desire to obtain terminal facilities at Duluth, which the city cannot give except on Minnesota Point, the inside face of which affords the best dock frontage in the harbor.

The land occupied by the canal belongs partly to the city and partly to individuals.

The State of Minnesota has power to authorize the bridge over the canal, and has granted such authority to the City of Duluth. The city waives its rights, and submits to the authority of the United States in the premises.

A denial of the privilege would deprive the City of Duluth of twenty miles of the dock frontage.

Vessels, in getting to existing docks, are required to take a tortuous course up bay and river through two bridges, with others in prospect.

Shipping business is now scattered over too much territory.

The area of ground on the immediate city front now available for docks and railroad terminals is extremely small.

It is denied that politics or real estate speculation influences Duluth in this matter.

It is denied that the bridge proposed would obstruct navigation.

The allegations of fact in the statement of Captain McDougall are denied or explained.

The shipments of wheat have amounted to $35,000,000 in one year.

Iron mines of fabulous extent and value are tributary to this port. The aggregateof moneyed interests requiring better docking and shipping facilities is over $700,000,000.

It is claimed that vessels entering the canal could be notified in ample time in case anything prevented the operation of the proposed bridge.

In clear weather vessels could be sighted from the bridge when twenty miles distant, and fogs are not accompanied by wind.

Even in violent storms they have never known vessels to have any considerable difficulty in passing through the canal.

The anchorage outside the canal is good, and would be available in case of trouble with the bridge; or vessels could make the harbor through the channel at the southern end of Minnesota Point.

Denied that there is plenty of room for docks, centrally located, elsewhere than on Minnesota Point.

Claimed that the combination of circumstances required to prevent a vessel passing through the canal after the construction of the bridge would be extraordinary and thus far unheard of.

The City of Duluth will agree to erect this bridge after navigation closes, thoroughly test its operation before navigation again opens, and to remove it in case the slightest hindrance to its operation should appear.

Directly in front of Duluth, but cut off by the canal from all commercial intercourse, lies a suitable territory of sufficient area to accommodate a population of 100,000 people, having ideal conditions for establishing twenty miles or more of dock frontage. Duluth needs and must have a greater area of level territory, more dock room centrally located, more railroad terminal grounds. She can get it on Minnesota Point and nowhere else.

A tunnel under the canal would cost not less than $500,000, and would probably cost twice that sum or more. The proposed bridge could be built for $150,000; Duluth could raise the latter sum, but not the former.

A street railway is now established on Minnesota Point. It accommodates the regular residents, as well as campers and tourists. It has no connection with Duluth, and a connection should be established by the construction of a bridge.

It is cited that Chicago, with a population of 1,100,000, had 22,000 arrivals and clearances last year as against 3,600 at Duluth with a population of 50,000; and yet Chicago was able to transact its business notwithstanding that its river is spanned by more than twenty bridges.

Owing to increase in size of vessels, the number of arrivals and departures will not increase in ratio with the tonnage.

It was admitted during the oral discussion that in a few years, say five, the traffic across the bridge might become so great as to make it impossible to accommodate it without unreasonably obstructing the canal. In that event, it was stated Duluth would make a tunnel, but cannot raise the money to do so now.

It was claimed that, if Duluth were required to build a bridge so perfect as to be absolutely free from liability to derangement through human defects in design, construction or operation, the city would be subjected to a rule which would stop all human progress. Further, that everything done by man is attended by more or less risk, and it would therefore be unfair to insist upon absolute perfection in a device for passing traffic across the canal.

It is submitted that, in designing this bridge, Duluth, regardless of cost, has invoked the resources of the ablest engineers to provide all the safeguards which human foresight can devise, and that it is neither just nor fair to demand more. She protests that her progress should not be stopped for lack of a surety that would be superhuman.

Duluth would be the last to place a serious obstruction across the entrance to her harbor. She only seeks a way, within her financial ability, to utilize her rightful territory.

Duluth imperatively needs Minnesota Point as terminal grounds for new railroads. Several are now seeking such facilities. They do not exist except upon the land in question. If they can not get them at Duluth they must go elsewhere.

It is denied that any serious difficulty exists in entering Duluth harbor in any sort of weather. It is claimed that vessels can always haul up outside and either lay to, cast anchor, or enter south of Minnesota Point.

It is claimed that serious danger to shipping could be threatened only in case the machinery of the bridge should fail to operate at a time when one or more vessels were approaching during a severe northeasterly gale, and that the chance of such a conjunction occurring, according to the theory of probabilities, would be only 1 to 2,800,000.

Duluth will agree to keep the bridge open at night during stormy weather; also in the daytime during unusual northeast storms. And in case the increase of shipping should be so considerable as to render the bridge an unreasonable obstruction, they would keep it open altogether during the season of navigation, and only use it as a bridge during the winter season when there is no navigation. It was stated that the city would enter into bonds to guarantee these propositions. The city will also agree to adopt every practicable safeguard against accidents, including the best methods of signaling, and to remove the bridge immediately should it actually prove to be an unreasonable obstruction.

It is claimed that Duluth is the easiest port to enter in the world, no matter what the weather may be; and the record is cited to show that heretofore but trivial mishaps have occurred to vessels entering the harbor.

Opinions of well-known experts in bridge and elevator practice are submitted to the effect that beyond a reasonable doubt the proposed bridge could be operated without interruption.

The foregoing cover the principal points made by the advocates of the bridge project. In like manner the arguments of the opponents of the bridge may be briefed as follows:

It was asserted that, at present, there are only about 200 people on Minnesota Point, and that the land is not needed for dock frontage, there being a great abundance of room still unoccupied in Duluth and vicnity; that the scheme is advanced in the interest of speculators; that northeast storms, which usually occur late in the fall and are generally accompanied by snow, have a clear water sweep of 350 miles; that the lake shores converge so as to form a great funnel, the apex of which is the canal, up which the storms sweep with unobstructed force, creating very heavy seas at and through the canal, even to such an extent as to sometimes prevent vessels from lying at the docks inside the harbor near the prolongation of the canal.

Several great storms and their severe effects are cited in detail, during which a breakwater and some vessels were wrecked. Actual experience of navigators is cited to prove the danger of this entrance in northeast gales. It is stated that during one storm the waves rolling through the canal made it impracticable to load vessels at the wharves of Duluth. It is further stated that waves in the canal were observed running as high as 12 feet above the canal piers and spreading out as far as 50 feet on each side, and the opinion is expressed that if they had encountered any obstruction on the banks of the canal the resulting spray would have been thrown to the height of 50 feet or more. In case of snow or freezing weather, such obstructions would soon have been covered with ice.

It is asserted that currents of 6 or 7 miles per hour have been observed in the canal and their directions changed in half an hour.

A case is supposed of the east and west bound shipping being both caught in a severe gale and driven into Duluth entrance coincident with a failure of the bridge machinery, and the disaster which would probably occur under these conditions is described.

Capt. McDougall asserts that in severe storms all vessels in the immediate vicinity must enter through the canal; that they can not enter south of Minnesota Point; that during the season of 1891 nearly 4,000,000 tons of freight passed through the canal, carried by more than 200 vessels, having an aggregate value exceeding $30,000,000.

It is claimed that under stress of weather vessels might get so close that they could not haul off in case of unlooked-for hindrance to the operation of a bridge; that Duluth is a difficult harbor to enter, and under certain conditions a very dangerous one.

It is stated that if the bridge traffic should be inconsiderable it would not be just to create an obstruction to accommodate it; while if it should prove to be considerable, it could not be accommodated without blocking the canal traffic.

It is stated that Duluth can have easy and sufficent access to Minnesota Point (1) by a tunnel; (2) by a trestle bridge with a draw in it across the bay; (3) by means of a ferry boat. With these available, it is claimed to be unreasonable to insist upon reaching that territory by means of a dangerous obstruction at the very entrance to the harbor.

It is claimed that Duluth Harbor is difficult of entrance because, although narrow, a good speed must be maintained while passing through the canal. The difficulties increase with the size of the vessels, and these are rapidly increasing in size. That very large vessels can not be brought to a stop while passing the canal in strong easterly weather, and consequently the existence of any bridge over it would invite disaster.

It is predicted that this little canal is destined to become one of the world's great concentrating points of shipping; that this will result in a necessity for widening it considerably, and that the existence of a bridge over it would greatly retard, if not prevent, this work.

It is asserted that at the bottom of this great funnel at Duluth the storm effects are worse than at any other place on the lakes.

To the argument presented for and against the bridge by the opposing interests, the board submit the following description and facts of record.

At its western extremity, the shores of Lake Superior converge under a sharp angle, near the apex of which lie the harbors of Duluth and Superior City. At a point in the angle where the opening is about 9 miles wide, a low sand point extends across and incloses a great natural harbor, the Bay of Superior. Only one natural break occurs in it, and here the waters of St. Louis and Nemadji rivers effect an outlet to the lake. This outlet is near the southern extremity. It has been utilized as a harbor entrance and the government has built piers and otherwise expended considerable money to improve it.

Something less than a mile inside this natural breakwater, where the lakeshore lines converge to an opening of about 5 miles, occurs another spit lying substantially parallel to it. Here again the opening is nearest the southern end. It furnishes an outlet for the St. Louis river. The north end is called Rice's Point, the south end Connors Point. The angular opening of the lake behind this spit is a large sheet of water called St. Louis Bay, the upper portion of which is the estuary of St. Louis river.

Superior and St. Louis bays are quite shallow, except where the waters of the Saint Louis river form through them a narrow channel to the lake. Harbor room in either for large modern vessels has to be provided by dredging.

The exterior formation making out from the north shore is called Minnesota Point. It is about 6½ miles long. That proceeding from the south shore is called Wisconsin Point, and is nearly 2½ miles long. The two have width varying from 200 to 1,000 feet, and rise but a few feet above the level of the lake.

Exterior to Minnesota Point the lake bottom falls rapidly away to considerable depths, especially in the angle at the north end. Along this point it is reported by the citizens of Duluth that vessels can safely ride at anchor in all conditions of weather. The physical conditions at this locality are such as to indicate that there might be times when such anchorage would be risky. A lake survey chart of 1861 shows, at the south end of Minnesota Point, a channel into Superior Bay with a least depth of 10 feet. This was prior to any improvement. An Engineer Department map of 1891 shows a depth here of 16 feet; but the date of the soundings is not given.

The St. Louis river, in this locality, forms the boundary between the states of Minnesota and Wisconsin. On the south shore of the lake opening, have sprung up the Wisconsin cities of Superior and West Superior, while on the north has been created the Minnesota city of Duluth. The rivalry between these cities is intense and bitter, to the extent that the discussion of anything affecting the entrance to the port behind Minnesota Point, is very much disturbed by local issues.

In the fall of 1870 the city of Duluth began cutting a canal across Minnesota Point, near its shore end, for the purpose of effecting a quick entrance to her own harbor front. This proceeding developed great opposition on the part of Superior and the State of Wisconsin, on the ground that the waters of St. Louis river could not keep sufficient channels scoured through two inlets, and that the one at the south end of Minnesota Point, being farthest away, would suffer. The contention resulted in the construction of a dike across Superior Bay from Minnesota Point to Rice's Point, which cut off the waters of St. Louis River from an escape through the canal. The following extract from the report of the Chief of Engineers, for 1879, gives some of the subsequent history of this contention:

In the spring of 1871, an injunction was issued at the instance of the War Department, restraining further operations in prosecution of the canal. This was subsequently dissolved, upon the execution by the city of Duluth of a bond for $100,000 to secure the construction of a dike extending from Minnesota Point to Rice's Point, and isolating the harbor from the rest of the bay of Superior; said dike to be completed by December 1, 1871. Under this agreement, work was resumed and the canal completed during the working season of 1871.

It was 250 feet wide, and lined with crib-work piers, which extended to deep water in the lake, where the opening widens to 290 feet. The time for the completion of the dike was extended, at the request of the authorities of Duluth, to March 15, 1872, at which date it was reported complete and offered for inspection to the United States authorities. Its construction was wholly unsuited to the requirements of such a work, being made of light crib-work ballasted with stone and filled with sand. It proved to be utterly inadequate. The filling was washed out, and the crib-work in part, floated out of place; in part was crushed by ice.

No action was taken on the bond, which was pronounced worthless by eminent lawyers, the city not having legal authority to execute the same.

Since the date of this report the dike has practically disappeared. The canal remains, having a length of about 1,300 feet. The distance from the outer end to Lake street, the proposed location of the bridge, is about 900 feet.

Starting from the northern shore of the lake, some 2,000 feet from the base of Minnesota Point, the United States built a breakwater, which in 1872, had reached the length of 1,200 feet. It was formed of cribs 30 feet wide by 50 feet long, and was provided with a decked superstructure to a height of six feet above the water level. Although built in the most substantial manner of such structures on the lakes, it was wrecked by a storm which occurred on November 14, 1872. But little of it now remains, and it has been abandoned.

The cause of this destructive action is to be readily found in the formation of the land on the northern shore of the lake in this vicinity. Rising to a height of about 700 feet above the lake level, it seems to direct easterly winds towards the location of the breakwater and the entrance of the canal, rolling the resulting seas, with accumulated force, in the same direction. It is easily conceivable that their force should prove almost irresistible by any structure less substantial than those built to withstand ocean storms. The destruction of this breakwater supports, to some extent, the assertions made by the opponents of the bridge concerning the extreme severity of the wind and wave action at this locality during unusual gales.

Duluth is, at this time, both a local harbor and a harbor of refuge. The distance to Two Harbors, the nearest shelter on the northern shore, is about 27 miles, and the distance to Bark Bay, the nearest shelter on the southern shore, is about

45 miles. Hence a vessel to leeward of these, with easterly wind, has no harbor available but Duluth; and, of necessity, must make it.

CONCLUSION.

The Board do not admit the extent of the dangers recited by the opponents of the bridge project, and fully recognize the great advantage to the city of Duluth which would accrue from a suitable means of communication with Minnesota Point. The latter clearly appears to be a necessity to the future growth of the city, as well as to the commerce which promises so soon to pour through her gates; and every foot of dock frontage behind that strip of land ought to be available. There ought to be considerable concession upon the part of each of the conflicting interests involved and each should yield a fair measure.

The design of the lift bridge proposed is one of great merit, and the details seem to be well studied and arranged. Any objections to the plan which have appeared to the Board are of minor character and do not extend to the main proposition, because they can be readily obviated. A complete description of the bridge is to be found in the papers and drawings* submitted by Mr. J. A. L. Waddell, the engineer who designed it.

It is to be understood that these favorable remarks apply to the design and not to the question whether a lift bridge is to be preferred at this locality. As a matter of fact the Board think that a properly constructed swing bridge would better fulfill the requirements, except as to the area of ground that would have to be occupied by the shore-arm of the structure.

The City of Duluth states that she can afford to build the bridge proposed, but cannot afford to construct a tunnel (which is admitted to be a complete solution of the problem), and that if she can not have a bridge she must be deprived of the use of Minnesota Point, the only direction in which the city can expand for commercial purposes. This is a strong argument and appeals to the sympathy of the Board, especially in view of the well known activity and enterprise of the people of Duluth, which certainly deserve all the encouragement that can properly be extended. But the Board feel compelled to put this aside and to deal with the question regardless of sentiment. They must look to the future, and base their opinion upon what seems to them best for the interests of all concerned.

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*Not printed.

In view of the facts and arguments detailed the Board concludes that it is not advisable to authorize the construction of any bridge across the canal entrance to the harbor of Duluth, Minn. They believe that the dangers and difficulties to shipping which would result from the bridge proposed have been overestimated by its opponents, while the degree of obstruction which would be due to such a structure has been underrated by its advocates. Any bridge over a water way is a menace to navigation, but the propositions of the City of Duluth, if carried into effect, would reduce them to a minimum in this case.

The City of Duluth proposes certain guaranties looking to the proper operation of the bridge, and even to its removal in case it should prove to be an unreasonable obstruction. The probable value of such a guaranty is indicated in the closing paragraph from the report of the Chief of Engineers, heretofore quoted.

If there were a breakwater outside of and covering the entrance to the canal, such that vessels would approach and pass the canal free from danger due to stress of weather or perils of the sea, the conditions would differ so much from those actually existing that the Board might find it less difficult to reach a conclusion that would be satisfactory to Duluth.

One very important factor in leading the Board to their conclusion is their disinclination to establish a dangerous precedent. The piers which border the canal at Duluth are essentially the same in general function as those which are found at the entrance of the principal lake harbors, and the canal itself corresponds exactly with the throat of all harbors where the entrance is between piers. It is the point where the mariner passes from the perils of the sea into the shelter of the harbor. He approaches this point and sometimes passes it in the midst of a struggle for life and property. Such a point can not be too free from obstruction, or the possibility of it. If a bridge were authorized over the canal at Duluth there could be no reasonable objection to permitting such a structure at any other exposed harbor entrance on the lakes; and without doubt, applications for authority to bridge other harbor entrances would rapidly follow upon the granting of such a privilege at Duluth, thus leading to a condition which would be unendurable.

Statements and arguments made to the Board have been largely reduced to writing by the parties presenting them, and are submited herewith as follows:

(1) Description of the lift bridge, with drawings, by Mr. J. A. L. Waddell, engineer.
(2) Letter of Mr. Thomas E. Brown, consulting engineer, approving the plans of said bridge.
(3) Letter of Otis Brothers, makers of elevators and hoisting machinery.
(4) Letter by Mr. K. Bryan, chief engineer Hale Elevator Company, approving the bridge, in detail.
(5) Argument of Mr. Henry Truelsen, president Board of Public Works, Duluth, Minn.
(6) Argument of the City Council of Duluth, by Alderman Charles A. Long.
(7) Argument of S. L. Smith, Esq., city attorney of Duluth.
(8) Oral argument (opening) of Mr. S. A. Thompson, representing the Chamber of Commerce, Duluth.
(9) Oral argument (closing) of same.
(10) Closing argument of Mr. Henry Truelsen, president Board of Public Works, Duluth, Minn., and J. A. L. Waddell, consulting engineer.

(11) Argument of J. W. Miller, harbor master port of Duluth.

(12) Argument of Captain Alexander McDougall.

(13) Argument of Vessel Owners' Association.

(14) Argument of Lake Carriers' Association by its delegates, W. Livingston, Jr., James Davidson, Charles H, Keep.

(15) Telegraphic protest of vessel owners of Buffalo, N. Y.

(16) Argument and protest of vessel owners of Milwaukee, Wis.

(17) Protest of Joseph Austrian, of Chicago, Ill., manager Lake Michigan and Lake Superior Transportation Company.

(18) Request of F. C. H. Arntz and L. E. Sangdahl, of Milwaukee, Wis., that their plans for a bridge be considered.

There is also inclosed a map* of the harbor of Duluth, Minn.

All of which is respectfully submitted.

O. M. POE,
Colonel, Corps of Engineers.
WILLIAM LUDLOW,
Major, Corps of Engineers.
W. A. JONES,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

1. DESCRIPTION OF PROPOSED LIFT BRIDGE ACROSS SHIP CANAL AT DULUTH, MINN.

This bridge, as shown by the accompanying plans, is designed to consist of a simple truss span, 257 feet long between centers of bearings, so supported and constructed as to allow of being raised vertically to a sufficient height to permit the largest lake vessels to pass unobstructed through the canal, the clear width of which, 250 feet, will not be reduced.

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*Not printed.

The distance from the surface of the water in the canal at its ordinary stage to the lowest part of the bridge, when it is raised to its highest position, will be about 140 feet; and the corresponding distance for the lowest position of the structure will be about 7 feet.

At each side of the canal there will be a strong, well-braced, and guyed tower about 195 feet high above the water level; carrying at its top built steel and iron pulleys 15 feet in diameter. Over these pulleys 48 steel-wire ropes 1½ inches in diameter will pass; one end of each of these ropes will be attached to an end pin of the truss, and the other end to one of the counterweights, which counterweights will be so proportioned as to just balance the dead weight of the span. The weight of the cables is counterbalanced by that of the cast-iron chain shown on sheet No. 1 of the accompanying drawings.

On account of this counterbalancing all the work that the operating machinery will have to do will be to overcome the friction, inertia of the mass, and the varying dead weight of the bridge, due to dirt, snow, water, etc. It is intended, however, that the bridge shall at all times be kept as free as practicable from the two former; and the latter can be, to a great extent, compensated by keeping on the ends of the approaches small weights either to attach to the under side of the main counterweights or to place on the ends of the span, according to whether the latter is heavier or lighter than usual.

All moving parts will be so designed as to reduce friciton to a minimum.

The power required to raise and lower the bridge will be supplied by two electric motors, either of which will suffice to operate the machinery; the second one is to act as a reserve.

From 20 to 30 horse power will be required to operate the bridge, according to the intensity of the wind pressure, provided the weight of the structure be balanced. Should the weight be not properly balanced the power required would be increased or the velocity would be decreased. There will be, though, a reserve of power in each motor which can be drawn on when the conditions for operating are most unfavorable; and it will be always practicable to throw the reserve motor into gear to meet emergencies.

The electrical energy will be supplied to the motors from the power house of the electric railway, some 8,000 feet distant, by means of a special wire; and to provide for the shutting down of the engines, when the line is not in operation between the hours of midnight and 5 a. m., there will be a storage battery of ample proportions adjacent to the bridge.

The calculated time for raising the bridge to the full height and lowering it again is five minutes; but it is probable that by using some of the surplus energy of the motor, or by employing both motors together, this time could be reduced. It would not be advisable, though, to increase the velocity much above that assumed, which is 1 foot per second.

The revolutions of the armatures will be communicated by worm gear to a shaft on which are keyed two 5-foot wheels or drums having on their peripheries spiral grooves for coiling up the four steel wire rope cables, each of which is fastened at one end to the top of the tower, at the other to the masonry of the pier, and at the middle to the operating drum. These ropes are kept taut at all times by adjusting rods at top and bottom. At each end and on the top of the span are two wheels that serve as guides for the cables. The *modus operandi* of said cables can be understood by examining the drawings, which show how they cross each other on one-half of the bridge and run parallel to each other on the other half, so that by turning the operating drum in one direction the bridge will ascend, and by turning it in the other direction it will descend. In case of accident to the machinery the span can be raised or lowered slowly by hand power applied to a capstan that can be placed on the railroad track about mid-span.

The approximate weight to be lifted is 950,000 pounds, consequently that of the counterweight must be also 950,000 pounds. As the weight of the wire cables and the cast-iron counterbalancing chains is about 62,000 pounds, the total moving weight will be 1,962,000 pounds, or a little less than 1,000 tons.

At the top and bottom of towers there will be hydraulic buffers capable of bringing the structure to rest from its maximum velocity without injurious shock; or else some equally effective method of accomplishing this result will be adopted.

After the bridge is down it will be held in place by locking gear attached to the ends of the span and operated from the machinery house.

The bridge will be steadied while in motion by rollers at top and bottom, as shown on the drawings, pressing against the flush surfaces of the main columns, and providing against excessive friction from both transverse and longitudinal wind pressure. With no wind pressure acting the rollers for transverse wind loading do not touch the columns, but those for longitudinal loading touch the columns at all times, being pressed against them by springs. This detail is necessitated by the contraction and expansion of the trusses.

There will be brakes on the operating drums for checking the speed and for holding the bridge at any desired height in case of there being an unbalanced load sufficiently great to set the bridge in motion. This brake, however, will not ordinarily be required, as the same effect can be obtained by reversing the electric current.

There will be in the machinery house a "peeper" or apparatus that will indicate when the lowest part of the structure has risen high enough to clear the masts of approaching vessels. This peeper is simple in its design and is covered by a patent.

In proportioning the cables that sustain the weight of the bridge an unusually large factor of safety, viz.: ten, has been adopted.

The diameter of the operating cables is seven-eighths of an inch, which gives also a large safety factor.

As can be seen by the drawings, the bridge is designed to carry wagons and motors outside of the trusses, and railway trains and pedestrians inside of same, but the pedestrians will have to pass beneath the inclined end posts and diagonally across the wagon ways to the sidewalks on the approaches. There can be no serious objection to. turning the pedestrian travel across the wagon ways, as it must cross them sooner or later in order to reach the sidewalks of the streets. The distance between central planes of trusses will be 25 feet, and the width of bridge from center to center of exterior hand rails about 52 feet. The center depth of truss will be 47 feet. The live load will consist of a train composed of two engines followed by cars weighing 3,000 pounds per linear foot, according to Waddell's standard train loads, class Z; also a highway live load of 100 pounds per square foot of floor. The combined load for the trusses, however, will be reduced to 4,200 pounds per linear foot. The stringers and cantilever brackets of the wagon ways will be proportioned to carry electric cars 18 feet long, each weighing 30,000 pounds, and having two pairs of wheels. The assumed wind pressure is 30 pounds per square foot on the exposed surface of the structure, including both trusses, when the bridge is closed, reduced to 25 pounds per square foot for the bridge open.

Each tower will consist of two main columns and two rear columns, with bracing on all four faces. From the tops of the main columns will extend guys of steel eye-bars attached to anchor piers and furnished with adjustments. The wind pressure is assumed to divide equally between the windward guy and the bracing between main columns. Near the top of the tower are two girders to support a timber platform, which will carry the counterweights until the bridge is swung, and which will serve afterwards to support said weights when the main cables of the bridge are being adjusted or replaced.

The counterweights will consist of masses of cast iron 10 inches wide, 12 inches high, and 10 feet long, strung on wrought iron rods that attach by rockers to the cables above, as shown on the drawings.

All metal in the structure is to be steel, except for adjustable members, which are to be wrought iron, and portions of the machinery and the counterweights, which are to be of cast iron.

The substructure will consist of masonry piers resting on pile foundations, as shown on sheet No. 1.

The entire design will be made in accordance with the best modern practice in American bridge engineering.

Respectfully submitted,

J. A. L. WADDELL,
Chief Engineer.

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2. LETTER OF MR. THOMAS E. BROWN, CONSULTING ENGINEER.

March 18, 1892.

Gentlemen:—At the request of Mr. J. A. L. Waddell, Chief Engineer, I have examined the plans of the proposed lift bridge for canal at Duluth, Minn, and have revised the calculations of power, etc.

I find the plans feasible and practicable, and the machinery proposed, while novel in its application, to be of a well known type, such as is in common use, and such as could be guaranteed by the makers.

The problem presents no mechanical difficulties; and there can be no doubt that a bridge built on the proposed plan, of good materials and workmanship, would be successful and safe in operation.

Yours, very respectfully,

THOS. E. BROWN, JR.

Board of United States Engineers.

3. LETTER OF OTIS BROTHERS, MAKERS OF ELEVATORS AND HOISTING MACHINERY.

NEW YORK, March 18, 1892.

DEAR SIR:—We have examined the plans of the proposed bridge for Duluth, Minn., and find that the type of machinery for the operation of the bridge is such as we use commonly in connection with our electric elevators, of which we have very many in successful operation.

The method of winding ropes on drums by means of motors and worm gears, and the method of counterbalancing, as well as the compensation of the weight of the ropes by chains, are all well known methods and in use by us; and we would be pleased to make you a proposal to furnish the machinery, motors, etc., etc., and will give you our usual guarantees as to workmanship, materials and performance.

Yours truly,

OTIS BROTHERS & CO.

J. A. L. WADDELL, Esq.,
Chief Engineer Duluth Lift Bridge.

4. A LETTER OF MR. K. BRYAN, CHIEF ENGINEER HALE ELEVATOR COMPANY.

DETROIT, MICH., March 22, 1892.

DEAR SIR:—After a careful examination of your plans for the lifting machinery of the Duluth bridge, I am satisfied that the plan is a most practicable one, and insures, without doubt, the satisfactory lifting of the bridge under the most unfavorable conditions. And, in fact, nothing short of a most extraordinary combination of circumstances, which combination of circumstances does not, from the testimony at yesterday's hearing before the Board of Engineers now sitting, yet seem to have arisen. Your provision of duplicate machinery for lifting the bridge, so arranged as to operate singly or coupled, insures in case of emergency, that the bridge can be gotten out of the way of a vessel in an exceedingly short space of time, viz.: about three-quarters of a minute.

With regard, further, to the constant availability of the machinery, the Hale Elevator Company, of Chicago, stands ready, should they undertake the construction of such machinery, to guarantee its operation. The problem is not a difficult one, and the machinery we would propose to furnish would be simply an enlarged engine, etc., of the same type we are constantly using for elevator work, and hundreds of which are in satisfactory working order to-day, and have been for a long time. Yorus truly,

KENNERLEY BRYAN,
Chief Engineer, Hale Elevator Company.

J. A. L. WADDELL, Esq., C. E.,
Chief Engineer, Duluth Lift Bridge.

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5. ARGUMENT OF MR. HENRY TRUELSEN, PRESIDENT BOARD PUBLIC WORKS, DULUTH, MINN.

Office of the Board of Public Works,
City of Duluth. Minn., March 18, 1892.

Gentlemen:—As president of the Board of Public Works and appointed as one of the committee to appear before your honorable Board, allow me to make a few remarks in regard to the construction of the lift bridge, the plans of said bridge having been selected by the Board of Public Works and approved by the common council out of twenty-one plans which were submitted to them in competition as the most feasible, surest and quickest of operation; and for the approval of said plan, application was made by the City of Duluth to the honorable Secretary of War, and your honorable Board having been appointed to hear the evidence and consider said plans and report your findings, whether or not in your opinion this bridge will, when built, in any way interfere with the free and uninterrupted travel of vessels entering the harbor of the Cities of Duluth and Superior, I expect that we shall be able to show that the plans which have been submitted to your honorable Board will prove to your satisfaction that no possible inconvenienc, danger or delay could result to the shipping interests, and with all precautions provided by our engineer in charge, in case any part of said bridge should give way, will, I think, prove to you that it is the most feasible and reliable plan of a bridge that could be designed for the place.

It will not be necessary for me to go into the details of Mr. Waddell's plans; these will be explained sufficiently by himself, so that anything I may say could not add to the information you will obtain from him, and with your permission I will briefly refer to the objections raised by the vessel owners, claiming as they do that it would be detrimental to their interests to allow the building of a bridge across the Duluth Ship Canal, and the reasons they advance are various, and no doubt should receive your careful consideration. But, gentlemen, you must bear in mind that it is an admitted fact that vessel owners are opposed to any and all bridges on general principle, and, in order that no possible delay should occur to their vessels, they for selfish reasons see all imaginary dangers to their floating property where there are none. Being blinded to the real facts in the case on account of their own self-interests, for which the interests of every other class of citizens must give way, it looks to me very much as if they imagined that the waters of the lakes, rivers and harbors are their undisputed domain, and no matter how the general public may suffer or be inconvenienced must not be considered, but they themselves must not suffer any loss of time.

It seems that they are rather selfish in their demands and the sooner that they find that the general public has rights which even the Lake Carriers' Association and ship owners in general must respect, the better it will be for all classes of citizens living in cities and towns bordering on our lakes and rivers. I have no other desire than to see justice done in this matter to all parties, and that is all the citizens of Duluth ask of your honorable Board, and I have no doubt of your ability to decide this question on its merits, and the reason I have referred to the opposition was to show that self-interest was their motive and a party is apt to be blinded to the real facts in controversy where self interest is at stake.

Time and again we have been told what great things have been done by vessel owners for the upbuilding of Duluth, and while I will give due credit to them, a great many other factors have entered into the natural conditions in the upbuilding of Duluth and Superior, and must receive due credit and are entitled to the same recognition as the interest of shipowners. The City of Duluth has attained her commercial standing from her geographical location. Being located on the head of Lake Superior, the extreme lake terminal to the west, it was natural that a large city would some day be built on the head of Lake Superior, because it is here where the extreme navigable waters and rail would meet, and as fast as the country to the west developed so would the commerce of Duluth increase, and it is due to the location of Duluth that lake and rail commerce has increased to such large proportions as statistics show.

But the main factor in the upbuilding of Duluth was the building of railroads opening up to communication the fertile lands of Minnesota, Dakota, Iowa, etc., making the country west of the Banning line tributary to Duluth. But still other factors have entered into the upbuilding of Duluth, and those were the push and business ability of our western business men in the building of elevators, docks, and warehouses. This made it possible to handle the wheat, flour, coal, and merchandise brought into and shipped out of port by rail and vessel, and as the country west of us developed, so increased the railroads in number and capacity, and also the vessel-carrying capacity. Now when we are told that the vessels carrying the freight to and fro have built up Duluth, we must take it with due allowances. Had it not been for the railroads and facilities provided by our business men for receiving and shipping, no more boats would come to Duluth and Superior to-day than twenty-five years ago, when an occasional boat would bring some supplies for a few pioneers then living at the head of the lakes. So we may safely say that a great many factors enter into the upbuilding of a commercial city, and no one factor must claim and cannot expect the right to be alone entitled to consideration and that everything else must give way for their individual benefit.

Now, let me briefly state for your consideration what position the City of Duulth, or its people, occupy in the matter under controversy. I claim that the people of the City of Duluth are more vitally interested in not in the least having any impediment or obstruction in the way of navigation than even the vessel owners, and it is essential to our present and future welfare that all facilities for our rapidly increasing trade as regards both railroads and vessels should be so extended as to meet the demands, and it is in view of such extension that the people of Duluth desire to bridge the canal and bring the most valuable property on the head of the lake, viz.: Minnesota Point, into close communication and thereby give increased facilities for railroad terminals, docks, manufactories, and for shipping. If the citizens of Duluth would feel that by building a bridge across the canal would mean an obstruction to our harbor they would not for a minute entertain such a proposition, and I as one of the committee elected by the Common Council of the city would not be here before your honorable Board urging the favorable consideration of our plans. But while the city is interested to lay no obstruction in the way of navigation, she is also very much interested in extending to the several railroads now in course of construction all facilities for cheap terminals, and they can only be had by making Minnesota Point available for railroad purposes and thereby adding seven miles of the finest dock frontage to our beautiful harbor, and if this dock front is improved, making a system of slips as on the north side of our harbor, it would add thirty odd miles of dock front to our harbor and would give us the finest railroad terminals in the United States, and all this dock front would be in close proximity to both Duluth and Superior entrances.

Along Minnesota Point, the bottom of the bay being of clear, clean, coarse sand, docks could be built at a great deal less cost than at any other part of our harbor, and with railroad facilities would at once bring this valuable property into use, and in place of this bridge being detrimental to interests of vessel owners, would prove a great benefit in the saving of time in making landings, and Minnesota Point forming, as it does, a natural breakwater, no storms would at any time imperil vessels lying at the dock, as is now the case when a heavy northeaster is blowing, and vessels lying along the docks at the west side of the harbor are at times in great peril.

Therefore, let me say that the gentlemen interested in the carrying trade who have come before your honorable Board to oppose the building of our bridge are doing themselves a great injury, and I hope that after fully considering this matter they may, for their own benefit, be allowed to withdraw their opposition, and I would urge upon you gentlemen of this honorable Board to carefully consider our plans and consider the interests of Duluth, the interests of the railroads who are about to enter Duluth and desire terminals at low cost, and which Duluth could not furnish at any cost unless Minnesota Point is made available for railroad and manufacturing purposes. I am perfectly satisfied to leave this whole matter in your hands feeling that you may decide this matter without fear or favor and with due regard to justice to all parties interested, and I will add, should this bridge at any time prove the least obstruction to navigation, the people of Duluth will be the first to ask for its removal.

Board of United States Engineers.

6. ARGUMENT OF THE CITY COUNCIL OF DULUTH BY ALDERMAN CHARLES A LONG.

Lying directly in front of the City of Duluth is a strip of land projecting out from the main land 7½ miles long, and within dock lines over 1,600 feet in width, comprising a total area of upwards of 2,000 acres. All of this immense territory is situated, and centrally, too, within the city limits of Duluth. At a distance of three-quarters of a mile from its base this strip is separated from the main land by an artificial channel constructed and paid for by the citizens of Duluth, and which is known as the Duluth Canal, furnishing one of two means of ingress and egress to the Duluth Harbor. The land occupied by the said canal belongs partly to the city and partly to private individuals. All of its navigable waters are within the limits of State of Minnesota. It has been maintained by the Courts that across this canal, or any body of navigable water within the limits of the State, the State has authority to construct, or delegate to others the authority to construct, a bridge, and that jurisdiction over such waters is not vested in the United States Government.

The construction and continued maintenance of this canal has retarded improvements of every nature and description on this strip; has deprived the City of Duluth of between twenty and thirty miles of dock frontage on its harbor side, necessitating a tortuous course up the bay, through at present three, and in the near future probably six, bridges, thus scattering the business over an unnecessarily wide expanse of territory, and throwing many difficulties in the way of prompt handling of our import and export trade. The topographical situation of Duluth is somewhat peculiar. The amount of territory in the central portion available for the use of docks, elevators, railroad yards and tracks, and manufacturing establishments is extremely limited. It is universally conceded, even by those who in this matter are its fiercest opponents, that the allowing of this immense and valuable territory to remain idle would be a policy suicidal, not alone to Duluth, but to all the vast interests of the great Northwest.

Various gentlemen and associations connected with the vessel interests, and possessed of strong and unmovable prejudices against anything whatsoever in the nature of a bridge, on general principles, have seen fit to make the one proposed no exception to the rule.

We appear before you clearly invested with the legal right to construct this bridge over this canal. It is not our wish, however, to unnecessarily antagonize the vessel interests as a whole or in part. You have had filed before you written objections from Capt. Alex. McDougall, The Cleveland Vessel Owners' Association, and The Lake Carriers' Association of Buffalo. In addition to communications the representatives of these objectors here present have had the most ample opportunity and liberty given to them by your honorable Board to make more clear and explicit their objections, after a study of the plans of said bridge and adequate explanations by the engineer in charge.

Indeed, we say that the courtesy and fairness which has characterized this hearing on the part of your honorable body is a matter of extreme gratification to ourselves and we doubt not to all parties concerned.

Now let us consider seriatim the objections submitted, verbally and in writing.

In the case of Captain McDougall it may be well to state that although a resident of Duluth, the bulk of his interest lies within the rival city of Superior, Wis., across the bay, a city which in its insane jealousy of Duluth has constantly and persistently opposed by every means in its power every project set on foot by the people of Duluth tending to advance the growth of her commercial interests, whether the growth of those interests at Duluth jeopardize the welfare of Superior or not.

Mr. McDougall says that but 200 people reside on this strip.

There are nearly 600, as shown by the fact that at the last municipal election the registry showed ninety-eight registered voters. To the silly argument the promoters of this enterprise are people who have some political interest in the city and own most of the property on the island of Park Point and want to increase its value by hampering the shipping interests with a serious obstruction, we desire to enter a flat denial. If a vote of the people of Duluth at large could be taken at this time on the advisability, if not the absolute necessity of the immediate building of this bridge, at least ninety-five per cent. of the vote would be in its favor. It resolves itself simply into a question as to whether or not it is worth while and for the best interest of the city to bring into its immediate connection with it, thousands of acres of land, available for all business purposes, by the construction of a bridge presenting absolutely no obstacle whatever, to the passage of vessels at all times and and seasons, and under the most unfavorable conditions with perefect safety.

Is there a city in this country similarly situated that would have allowed a matter of such vital moment to lie so long forgotten?

In objection 3 of Captain McDougall's paper, we would say that at the time of the storms referred to, the canal was less than one-fourth of its present width, and provided with no safeguard whatever. The conditions which prevail to-day would render utterly impossible such occurrences as he refers to.

The captain states that "through this canal there entered in 1891 over 200 different steamers and vessels worth more than $30,000,000, and the idea that such a channel should be obstructed and so much vessel property endangered simply to advance the interest of a few real-estate speculators is ridiculous in the extreme."

Your committee who are here to advocate favorable action on the part of the Government and the construction of the bridge, indignantly deny the charge of Captain McDougall, that real estate speculators are in the remotest way connected with this important question. The only large property owner known to your relator as having landed interests on Minnesota Point is opposed to bridging the canal, and is largely interested in real estate in our sister city of Superior, and Superior as before stated joins with Captain McDougall in objecting to the bridging of this canal. If there is invested in the carrying trade of the lakes $30,000,000, there is also invested in the various railroads which focus at Duluth a capital so enormous as to almost dwarf in comparison the figures quoted. There are over 16,000 miles of railway, traversing a mighty empire, terminating at Duluth, representing a cost, with equipments, of at least $25,000 per mile, or a grand aggregate of over $400,000,000. These railroads furnish these vessels with their cargoes. These interests make the carrying trade of the lakes possible and profitable, have in fact originated and maintained it, by furnishing a constant stream of supplies, and are entitled to a hearing. Besides these, other roads representing over 5,000 miles and a further investment of $125,000,000 are knocking at our doors. More room, centrally located, is demanded for their proper and necessary accommodation.

The Northwest, in a single year, was interested to the extent of $35,000,000 worth of wheat brought to Duluth for shipment by these same railroads. The recent marvelous discoveries of iron in the ranges adjacent to Duluth have opened the world's eyes to the hidden wealth of ore, which in one form or another must find its way by vessel from Duluth to the sea. In one single mine there has been measured up 10,000,000 tons of ore, worth at the vessel's side $15,000,000. This is but one of a dozen mines equally productive. The aggregate of the moneyed interests involved, then, in having centrally located docks, elevators, factories and furnaces, railroad yards and tracks, both for the railroads now present, and those which are to come, foots up the enormous total of over $700,-

000,000. It is this tremendous combination of interests that Duluth proposes to accommodate by bridging this canal, and utilizing this vast and vacant tract of idle territory lying so close to the city's heart. These interests Duluth dares not jeopardize or imperil. Are the just claims of these vast interests to be ignored because timid vesselmen set up a supposed danger, where in fact, no danger really exists?

We submit to your honorable body that the vessel interests have no case. In a court of law we should move for a dismissal. It is beyond their province to dictate to Duluth and her allied interests what the exact means of communication between this island, artificially made, and the mainland shall be. It is not a question of tunnel or bridge; it is a question as to whether our proposed bridge places hindrances or obstructions in the way of navigation containing elements of danger or a menace to safety which do not already exist. With this bridge in position, is there a single vessel owner who would be frightened away from Duluth and her abundant cargoes by the alleged dangers or obstructions which its erection is imagined to bring about only under certain impossible conditions?

The Cleveland Vessel Owners' Association conceded the urgent necessity on the part of Duluth of acquiring this additional territory for business purposes. They claim, however, that the question of safety in entering the harbor is of greater importance. This we also concede, while maintaining distinctly that the safety of every vessel entering our harbor through this canal under any ordinary or probable condition is not abridged one iota.

If they admit, as they do, that the harbor of Duluth is difficult to enter because of the full exposure of the winds and seas, they must also admit that every master of a vessel approaching this harbor in the midst of winds and seas would, if a faithful officer, strive to have his vessel under perfect control, and would be in the full exercise at such times of such extraordinary resources as he might be possessed of to enter and pass safely through that canal, bridge or no bridge. The most ample time and opportunity would thus be afforded to signal such masters, as would be done, whether the bridge was opened, closed, or in any manner a bar or hindrance to his entrance. The proposed bridge is located about 2,000 feet from the harbor entrance. None but steam vessels would attempt the passage of this canal now or then without a tug, but so perfect are the provisions for opening the bridge, more than sufficient time would elapse between the appearance of a vessel at the canal entrance, driven by a storm, to admit of the bridge being completely raised before the vessel could cover half the intervening distance. This bridge is intended to be a permanent structure, but the development which we hope may ensue on Minnesota Point in consequence of its construction may result in its proving only a temporary affair, and also in the construction in the next five or ten years of one or two tunnels. The most enthusiastic vesselman could not do more for the removal of this bridge the moment it became in any manner a reasonable obstruction to navigation than would every citizen of Duluth.

The vessel interests which make it possible to utilize our great waterway from Duluth to tide water have done too much for Duluth to ever merit or obtain anything but the most friendly treatment and jealous care at the hands of the Duluth people.

We desire to impress upon your mind the fact that in clear weather vessels can be observed from the bridge level ten miles out at sea, and from the top of the tower over 20 miles. In foggy weather this of course would be impossible, but the presence of fog means absence of wind. We maintain in answer to the Cleveland vessel owners' objections, that they do not obtain in this case, and that the contemplated bridge offers no such hindrance or impediment to navigation as they describe.

The Buffalo Lake Carriers' Association advanced mainly the same objections as those submitted by the delegation from Cleveland. It possesses more merit, however, in that it recommends the construction of an extensive breakwater, as is the case at most impotant lake harbors. They contend, however, that in the time of heavy eastern gales it is a difficult and dangerous feat to bring a big and unwieldly vessel safely through the canal. We do not believe competent vesselmen will admit the truth of this statement. In this canal, at its present width and depth, we have never known of any considerable difficulty in bringing a vessel of any size through in the most violent of storms, but were this true, the fact seems to be blindly overlooked that there is most excellent anchorage outside the harbor, besides the Superior entry, for use at all times.

To their objections Nos. 1, 2 and 3 at the close of their communication, we have to say:

(1) It is not true that there is plenty of room for docks, slips, etc., for many years to come at places other than Minnesota Point, which are centrally located and which can be reached without going through one or more bridges besides the one we propose building at the canal.

(2) This is no scheme in the interest of a few land owners on Minnesota Point. Property located there would not enhance in value; except as improved and developed by those to whom it would furnish the most usage, and these would be the buyers, the railroads, and the shipping interests. The only scheme about it is that patriotic one, to remove all hindrances that now retard the growth and development of this most marvelous of cities.

(3) We submit that vesselmen recommending a drawbridge inside of the canal across the inside bay are reckoning without a full knowledge of the consequencess which would undeniably ensue. Such a bridge would receive fully as much traffic as the one we advocate, must of necessity be a swing draw, and the same vessel before transacting all of its business within the harbor and moving from dock to dock must also of

necessity pass through this bridge, not once only, but possibly a dozen times.

In conclusion, therefore, we submit that the premises taken by all the objectors to our proposed bridge are not tenable, however much so they might be under other conditions and circumstances. They are founded wholly and entirely upon suppositions. In the verbal arguments made before your honorable body, exceptions have been taken to the plan of the proposed bridge being a novel and unusual one. We respectfully ask that you refuse to consider any objections whatever to the plan of the bridge which do no not come from practical mechanical engineers fully competent to pass upon the merits or demerits of this or any other bridge structure. We are asked to suppose that the machinery will not work. We have the machinery in duplicate; we are asked to suppose that it was run by an incompetent man; incompetency is not yet at a premium in Duluth. We are asked to consider the unexpected and unheard-of event of the presence at the same time, at the same place, at the same hour, at the same minute, of a northeast wind, of a snowstorm, of a fog, of a rain freezing as it falls; of a clear or a cloudy sky; of an incompetent sailing master; an incompetent bridge engineer; the failure of machinery to work, either the original or duplicate; of all parties losing their heads, of no signals being given to either vessel or bridge until the bridge is ruined and the vessel sunk and the canal obstructed. We submit to your honorable body that such an unheard-of combination is preposterous even at Duluth.

In all candor, can any reasonable man imagine anything more improbable or impossible than such a simultaneity of events? There is less chance of any of the suppositious possibilities of the dangers above cited happening as a consequence of the building of this bridge than there is of the vessel being blown up in mid-sea or of the captain going crazy. We have listened most carefully to these objections, intending and desiring to remove all dangers from the realm of possibility to the domain of impossibilty. We find, however, our friends, the objectors, do not entertain the possible elements of danger so seriously as they do those elements which are altogether improbable if not absolutely impossible.

The City of Duluth has announced its perfect willingness to erect this bridge during the close of navigation, and to operate it under the supervision of any Board of Government Engineers under any difficulty and in all sorts and conditions of weather, making every possible test; and if at the end of such tests the bridge is pronounced to be in the slightest degree a hindrance or obstruction to navigation or the great vessel interests of the lakes, the City of Duluth stands ready to pledge itself in writing, upon the receipt of such report, to remove the bridge before the opening of navigation.

Desiring to express to you, gentlemen of the Board, our full and unbounded confidence in your judgment, and in the wisdom of your deliberations, and thanking you again for the interest manifested and courtesies extended all parties to this hearing, we leave the case in your hands.

In behalf of the City Council of Duluth.

Yours most respectfully,

CHAS. A. LONG,

Alderman.

The honorable BOARD OF UNITED STATES ENGINEERS.

7. ARGUMENT OF MR. S. L. SMITH, CITY ATTORNEY OF DULUTH.

CITY OF DULUTH,
Legal Department, Duluth, Minn.

GENTLEMEN:—There is one point upon which the inhabitants of Duluth are all united, and that is the connection of Minnesota Point with the main part of the city. Minnesota Point, as is well known, extends for 7 miles in a southerly direction, separating the waters of Superior bay from Lake Superior. To describe it tersely, I quote from William Sooy

Smith, civil engineer of the City of Chicago, as follows: "Minnesota Point is 7 miles long and about one-half mile wide, having an area equal to 9,000 fifty-foot lots. Its surface is level and its shore end near the business center of the city. It would afford 20 miles of dock front if cut into slips. The portion of it lying southward of the canal is now so difficult of access as to be scarcely available for business purposes." No one familiar with the fact would think of questioning the foregoing statement. It is also well known that there is but little level ground adjacent to the harbor on the Duluth side. Immediately in front of the city, cut off from all commercial intercourse, is a perfectly level territory, sufficient in area to accommodate 100,000 inhabitants, besides 20 miles of dock frontage, and in addition railroad trackage for all time to come.

When we consider that our railroad terminal facilities are already limited, our dock privileges well occupied in the immediate vicinity of the city proper, while the city continues to grow with a rapidity astonishing to every new beholder, keeping pace with, if not excelling, all others, is it strange or astonishing that we reach out and try to subdue the arid plain which lies before us?

We must have more territory, and we should have that which rightfully belongs to us and which lies at our very door. This territory is a part of our city, and is under municipal control, but is inaccessible for business purposes, because for commercial purposes a canal was cut which severed it from the inhabited portion of the city.

We offer to bridge the canal at our own cost, but recognizing as we do the jurisdiction of the Government over the waters of the great lakes, we appeal to the officials of the Government for permission to construct a bridge across the present canal.

We ask for permission to construct a bridge, because we have carefully counted the cost, and ask for that which comes within the measure of our ability to pay. A tunnel, we are advised by competent engineers, will cost $500,000, while a bridge, we are advised by equally competent authority, will cost less than half that amount. With us it is not only a matter of economy, but a matter of necessity. We must have the connection, and we must have it at the least possible cost.

Some question may arise as to the right of interference on the part of the Government, owing to the fact that all of Minnesota Point was, including that portion occupied by the canal, patented to the different individuals many years ago. In this manner the Government parted with its title. The canal was no part of the great lake, but is an artificial channel. The land after being patented by the Government was platted into lots and sold and resold, and some of them are now claimed by different individuals. It is true that the City of Duluth procured title to most of these lots and offered to convey them to the Government, but the Government refused to accept the conveyance, and so the title stands in the name of the city to a portion of the lots and in the name of certain individuals to another portion of them. However, we are not here to raise this question. Our appearance concedes the right of the Government to direct in the premises, and hence we pass the point. The most vital point in the case I am least able to discuss. I refer to the possibility and probability of constructing a bridge so as in no manner to prove a hindrance to navigation.

We believe, upon the authority of competent engineers, that this can be done. Anything that I might say on this subject would have but little if any weight with this Board, but but there are gentlemen present who are thoroughly competent to discuss the subject, whose convictions justify us in believing the project a feasible one.

Now, having thus briefly outlined the situation, I desire to present some additional facts.

1. It was through the foresight, energy, and liberality of our people that a great commercial metropolis has been built

at the head of the great chain of lakes. Had it not been for this there would be no demand for the vessel tonnage now seeking an outlet at Duluth.

Intimately connected with the growth of our city has been the construction of railroads penetrating all the states and territories which lie beyond. These roads, brought about through Duluth enterprise, take up and distribute the freights which we have made it possible for the vessel men to handle.

We have constructed docks with the same liberality with which we have donated lands and encouraged railroad enterprises, endeavoring to treat each fairly and with the same generosity; but, having in a measure exhausted our immediate privileges, we are desirous of further bestowing upon each equal advantages by giving to the vessel men a system of dock privileges unequaled and unsurpassed by any city on the continent. At the same time it is possible for us, by connecting Minnesota Point with the city proper, to bestow like advantages upon the railroad companies whose occupation of the ground is a necessity for carrying away the traffic of the lakes. The two must be connected; for, where land and water meet, the one must take care of the freight delivered by the other.

2. It is well understood that the bottom of the Superior Bay is free from rock and stone. This has been demonstrated by dredging all parts of it. A test well over 100 feet in depth, recently put down at the point where a bridge should properly be constructed, has demonstrated that nothing that could interfere with successful and easy dredging can be found. All, therefore, that is needed will be the ordinary amount of comparatively easy dredging to make the whole of Minnesota Point with 20 miles of dock frontage easily accessible for all vessels seeking an entry to Duluth harbor.

Much of our present dock system, as will be seen by reference to the plats exhibited, is almost parallel with the canal in a prolongated line. During northeast winds there must of necessity be more or less exposure to the swell of the water, especially in the landing of vessels, all of which, to reach the docks on the right, must make a short, abrupt turn in the full swell of a storm to enter the several slips. On the opposite side, along Minnesota Point, if proper dredging be made, a swing of the vessel to the left will at once put it beyond the swell and immediately behind Minnesota Point, free from the wind or swell of the water.

3. Minnesota Point for more than a year past has been traversed with a street railway which begins and ends without a terminal. By this I mean that it starts at the southerly side of the ship canal and extends down the point a number of miles, but cannot connect with the mainland in that direction by reason of the Superior entry. It is an isolated orphan, and, like the Almighty, it has neither "beginning nor ending;" yet, for all this, it is one of the institutions which have come to stay. Indeed, this is characteristic of all Duluth institutions.

Notwithstanding Minnesota Point is only accessible by means of the common yawl, it is the home of an enterprising and thrifty population composed of several hundred people. In the summer season (and we have summer the most of the year in Duluth) Minnesota Point is densely populated with campers and tourists from every quarter of the Republic. Hence a street railway line is a necessity; but it should have, as every one must concede, a connection with the main part of the city. It seems that every argument is in favor of some feasible means of connecting the city in one entire whole, and this, I trust, will be at an early day, by the construction of a bridge upon such plan as science alone can devise, and which, I have no doubt, will be fully demonstrated to the complete satisfaction of this Board by the eminent engineers whose province it will be to address you on that branch of the subject. My effort has been only to advise you upon such matters as I thought might not be familiar to you, matters outside the field of science and which pertain more to the question of necessity and the commercial importance of the matter under discussion. In conclusion I desire to say that the people of Duluth will await the report of this Board with the deepest anxiety and with the earnest hope that it will at an early day see its way clear to a recommendation for the building of a bridge across the "Rubicon" which separates and divides the most valued portions of our city.

S. L. SMITH,
City Attorney.

8. ORAL ARGUMENT (OPENING) OF MR. S. A. THOMPSON, REPRESENTING THE CHAMBER OF COMMERCE, DULUTH.

MARCH 22—3 P. M.

Mr. Thompson—I shall not detain you long, gentlemen, but it seems to me it may be worth while for us to present a resume of the points as we see them. I wish to say in the beginning that it seems to me that the vessel interests have confessed the weakness of their cause in advance, in that they have considered it necessary to secure the services of the most eminent admiralty lawyer in the United States to argue their case for them.

Mr. Goulder—What shall I do? I am ready to do anything after that.

Mr. Wardell—You might withdraw from the case and cease your opposition to the bridge.

Mr. Thompson—And I desire to say that the reputation which has preceded the gentleman has been fully borne out by what I have heard here. Although delivered against the cause which I represent, I must say that the address which he delivered I have enjoyed as an intellectual treat. I am a little surprised that a gentleman of such eminent reputation and such extended experience in litigation should have thought that any personal feeling entered into the exchange of compliments which has occurred in the course of this controversy. I assure him that there is nothing of the kind on my part, but it seems to me that it is only fair to say that, while the weapons that he has used may have borne a little higher polish, they were none the less keen than those which have been employed on our part.

It seems to me also that he has acknowledged in advance the weakness of his case by resorting to what is commonly known as "trial by newspaper." I was surprised to see the statement made in an interview with Mr. Goulder that the people of Duluth had completely given away their case in a reply to a question on yesterday.

Mr. Goulder—I am glad the gentleman has referred to that; I do not intend to interrupt his argument, but this gives me an opportudity to say that when I made the remark I supposed that I was talking only to some of my clients and had no idea that a newspaper man or anyone else who would report the matter was within hearing.

Mr. Thompson—I desire, gentlemen, first of all to recall to your minds the fact that the City of Duluth was first platted on the ground occupied by this canal; that the plat has never been vacated, and hence the streets and lots are legally in existence as they were twenty or thirty years ago, and for nearly twenty years before the construction of the canal; that the City of Duluth owns the real estate bordering on the avenue; that it legally owns this avenue now as it did before the canal was cut, and that under an act of our legislature we have a right to put a bridge across the canal, although this right is limited in the legislative act so that we have no right to put a bridge there which will constitute an obstruction to navigation or which will in the least narrow down this channel, which is 250 feet in width.

The eminent counsel on the other side has gone to a great deal of pains to magnify the dangers which are to be created by the construction of this bridge. I must give him credit for having built a larger superstructure on a smaller foundation than any other gentleman I have had the pleasure of listening to. He has objected to the bridge because we have called it a temporary structure. We insisted from the beginning that whenever this bridge should prove an obstacle to navigation it would be removed.

We believe, and he concedes, that the development of business would be such that in a few years it would be necessary to replace or at least to supplement this bridge by a tunnel, and it is only in that sense that we call the bridge a temporary structure. In all engineering experiments, it is found necessary to make use of temporary structures. This is especially true in the case of railroads. All authorities upon railroads agree that it is absolutely necessary that in the first place some wooden trestles and some wooden bridges must be used, and that lines must perhaps go farther around than is desirable, but a road must build up its business before it can properly undertake to replace these wooden structures with those of a permanent character and shorten its line by the construction of costly viaducts or tunnels. The West Shore Road was a good example of the result of a new road trying to enter full fledged into competition with an old and established line. Its competition was to be with the New York Central, with its four tracks and its roadbed solidified by years of use and constant labor, day in and day out, year in and year out. The management of the West Shore announced that they intended to build that road in such a manner that it would be safe to run express trains at a mile a minute from the first day it was opened for business. The result was that before the road was finished it went into a receiver's hands.

I remember when the Northern Pacific wanted to go across the mountains, to the coast they did not say, and I doubt if anyone could be found who would say, unless it should be the eminent counsel for the Vessel Owners' Association, that they must not run any trains to the coast until they had completed the great tunnel in Mullen Pass. Instead of that they built what is known as a switchback over the mountains, and over this they carried their passengers and freight until they had built up the traffic of their road and were able to sell their bonds and so could build their tunnel. All engineers will agree that we do wisely at Duluth to build a bridge instead of straining our credit to the utmost limit in order to build a tunnel. At the present time we do wisely to take that course which lies within our financial ability, and, even, if all the money needed were available, we do wisely to use a temporary method and a less costly method of reaching Minnesota Point until such time as the volume of business upon Minnesota Point is sufficiently developed to warrant the expenditure which the tunnel would necessarily involve.

Then the gentleman has gone on asking how those whom he represents are to be guaranteed against this, that and the other difficulty. He has instanced the fact that material will will break; that it sometimes proves to be of less strength than was expected; that men are human, and hence they err in judgment; that they are weak, and that accidents result from weariness and sleepiness on the part of engineers and bridge-tenders; that accidents happen which not only can not be foreseen, but for which no explanation is ever found after they occur. These things are all true, but it seems to me that if this argument is a valid one, we must necessarily suspend all progress. We ride upon railroad trains so that we can go from one city to another with speed and comfort, and yet it is possible that through want of attention, through the lack of sleep, through failure of signals, through mistakes of judgment, through unforeseen and unexplainable causes, or by reason of death, which may suddenly strike down the man who holds the throttle, accidents may occur. We take our lives in our hands every day and run all the risks which he so graphically describes. The failures of men, of vessels, of machinery do take place, but if I understand his argument, he claims that as far as Minnesota Point is concerned at least, we must not have access to that important territory until we can guarantee him against all these matters.

We go up and down in elevators, we ride in steamboats and railway trains, taking these risks every day. What is it that the law demands, the law which is the crystallization of human experience and the embodiment of justice? It demands that everything skill and human foresight can devise shall be provided. If that is not done, and accidents happen and men are sent to their death, those who send them to death through failure to make this proper provision are guilty morally, if not always legally, of the death of those who are killed. But when it is proven that every expenditure of human skill, and every necessary expenditure of money to provide all the safeguards which human foresight can devise was made, then if accidents happen we can only say it was the act of God and that no man is to blame. But must the progress of all the world, must the progress of even our little city of Duluth stop until we can give a guarantee to the vessel-owners which would not only be superhuman, but divine?

We believe that we have the full legal right to construct this bridge, but we are so anxious that it shall be so constructed as not to hinder navigation that we practically have waived our legal right and gone to the Government and asked permission to build a bridge.

Through the Secretary of War, we have asked for a Board of Engineers to consider the plans of the bridge which we propose. The counsel for the vessel interests has admitted that they are influenced by personal consideration. We must admit that we are also human and presumably influenced by our selfish interest, and we are glad that the decision of this question is not to be made by a jury of the citizens of Duluth, but by men who are not only skilled in engineering, but men who are just and fair; men who are outside of the personal interest of either party to this controversy; men who occupy judicial positions and will judicially weigh the evidence submitted and determine what is right and best for all concerned. We come to you declaring that we do not desire to put anything in the way, anything which would be an obstruction to navigation. We desire to find a way which is within limitations of our financial ablity, or if you choose to put it so, our financial inability, which will answer the purpose until we are able to find another way, which we hope and expect to have in addition to this, or in place of this, when the time comes that it is demanded.

Now, gentlemen, as I said yesterday, the question for you to decide is whether this plan as presented is a plan which will give to us the connection with our territory which we desire and which will not injure the vessel men who come to us and must continue to come to us if we continue to grow, if we are even to maintain our present position. The question, which as a matter of fact is to be decided, is simply this: Is there skill enough in the engineering profession of the United States of America at this day and in this age, with the experience we have had in triumphing over difficulties which are counted insuperable in the recent past—is there skill enough in that branch of the engineering profession which devotes its time and skill to building bridges to solve this problem, so that the interests of commerce on land may be subserved and the interests of commerce by lake shall not be injured? I am not an engineer and I shall not attempt to discuss engineering questions. So far as the plan goes or any modification of it that may be desirable, I shall turn that matter entirely over to you and to the expert engineer who is here to answer any questions that you may desire to ask.

I ask you once more to remember that we own the propery, we own the street, we have authority from the Legislature of Minnesota. I believe we have undoubted authority to build this bridge without asking permission of the Government, but we have laid that aside and come before you believing that they who ask equity must do equity. In asking justice at your hands for our interests, we do not desire to ask that you cross by a single hair's breadth the line between justice to us and justice to others. If, as engineers, you desire to suggest modifications the present plans, even if you should consider it desirable to recommend some radically different plans, we shall accept the decision you make, but we ask, and we confidently believe that you will not say, what we certainly are not willing to admit, that the profession to which you belong can not solve the problem here presented.

9. ORAL ARGUMENT (CLOSING) OF MR. S. A. THOMPSON, REPRESENTING THE CHAMBER OF COMMERCE, DULUTH.

Mr. Thompson—Mr. Chairman and gentlemen, as I understand it, the essential point which you are to consider to-day, is not so much whether any bridge is to be built as it is whether or not the bridge which we propose is a proper bridge to be built. The canal is not a natural waterway; it was constructed by the citizens of Duluth and we were bitterly fought for seven years by the citizens of Wisconsin before we were allowed to keep it open peacefully.

The first lots in the City of Duluth were laid out on Minnesota Point; the streets and avenues upon the Point were in existence some twenty years before the canal was constructed and they have never been vacated, nor has any portion of the plat been vacated, and the situation to-day is briefly this: The City of Duluth has the same right to the use of the avenues across the canal which it has always had; it owns not only the avenue of which the proposed bridge would be a part, but owns the lots fronting upon that avenue, some of which are under the water in the canal. We were not only fought for years by the citizens of Wisconsin, who denied to us the right to keep the canal open, but during the years when we thought it was necessary to ask permission from Congress to build a bridge we were fought as bitterly by the citizens of that State.

Finally, upon the report of the Chief of Engineers him–

self, we learned that in the absence of direct legislation by Congress the control of a waterway lying wholly within a State was vested solely and absolutely in the Legislature of that State. We have obtained the authority of the Legislature of Minnesota to construct a bridge across the canal; but were limited by the act granting this authority to a clear span of 250 feet, so that the channel for use of vessels would not be narrowed by a single inch, so that I believe, remembering we own the avenue, that we own the real estate fronting upon that avenue, that it is an artificial waterway, that it lies entirely within the State of Minnesota, and that we have authority from the Legislature of Minnesota—I believe, I say, that our legal right to construct this bridge is absolutely clear and unquestionable, subject only to the power of the General Government to order its removal if we build a bridge which shall prove to be an unnecessary or unreasonable obstruction to navigation.

We are here today particularly, it seems to me, to learn whether the vessel men own the earth as well as an undisputed title to the waters of the Great Lakes. We are told by the other side that the result of bridging the canal will be to so largely develop Minnesota Point that it will make this bridge very much in demand. And, if we may judge from what they say, their greatest fear is that we shall realize the development of population and business which we hope to gain by making a a connection between Minnesota Point and the mainland. I would like to ask some of the vessel men whether there are not only one, but whether there are not many bridges across the river in Chicago.

We have a populalion of 50,000; in Chicago there are 1,100,000; we had 3,600 arrivals or clearances of vessels last year; Chicago had nearly 22,000. I do not mean to say that conditions in Chicago are ideal by any means, but with a population more than twenty-fold greater it was found possible to do a business involving nearly seven times the number of vessel movements in a river obstructed not by one but by twenty or more bridges. I am asked if there is any bridge in Chicago taxed as the Duluth bridge would be if the development which we expect actually takes place. Not having the gift of prophesy it is a little difficult to foretell absolutely what will come to pass, but it seems to me that the size of Minnesota Point is so small comparatively, the business which will naturally center there is of such character, that there will never be a large resident population upon the Point. In my judgment the bridge across the Duluth Canal will never be taxed, at least by any movement of population, as many of the Chicago bridges now are. In the light of past experience I think it is also safe to say that in five years from now it is quite likely that there will be fewer vessels passing through the Duluth Canal than there are at present.

In looking over the list of arrivals and clearances and of the tonnage at Duluth for a series of years recently, I found that 1889, I think it was, the number of arrivals was less than the year before by about 180, while the tonnage was greater by about 283,000 tons. This is simply an indication of the fact that larger and larger vessels are being built all the time, a tendency which is shown in a very marked manner by the record of comparative arrivals and tonnage at the Soo Canal. The tonnage increased enormously year by year, while the number of vessel passages increased at a very much lower percentage and shows in some years an actual decrease.

I have recently had the honor to contribute my mite to the efforts which are being made for a deepwater channel, and when this becomes available, as we expect it will within five years, there will be a still further and still more marked increase in the size of vessels, so that a very much larger business than at present will be carried by fewer vessels than are now employed.

The testimony of a large number of leading railroad men in America, among them being W. C. Van Horn, who has gone within a few years from a minor position on a small road to the presidency of what is probably the greatest railway corporation in the world, is that Minnesota Point is the grandest natural location for railroad terminals in the world. When Mr. Church, the general manager of the Imperial Mill, which is now the largest flour mill in the world, was seeking a location, he looked across the harbor and said: "Oh! if Minnesota Point was only available." The testimony of men in a number of lines of manufacturing is that Minnesota Point would constitute an ideal location for their lines of business if only it were made accessible by some convenient means.

The length of Minnesota Point below the canal is 6½ miles. There is a dock line extending out some 1,400 or 1,500 feet, giving room for more than 21 miles of docks, all lying close to the harbor entry, quickly reached by vessels and perfectly sheltered from storms. There are only 48 miles of dock in the great commercial city of Liverpool, and we believe that this territory constitutes one of the finest natural advantages possessed by any city anywhere, and that we should be allowed to construct a bridge which will give us access to that territory and enable us to realize the increase in business and population to which we are entitled by our location and natural advantages.

So much has been said in some of the protests here about speculators that it would seem to be the opinion of the protestors that the entire population of the City of Duluth was composed of speculators alone. One of the first protests read here was from Captain McDougall, who testified to the desirability of Minnesota Point as a location for manufacturing establishments by endeavoring to locate upon that Point the yard in which he built the whaleback type of vessels, of which he is the inventor. Captain McDougall was particularly strong in his assertion that the whole movement for a bridge across the canal was instigated by a few speculators whose property would be increased in value. I represent here the

Chamber of Commerce of Duluth. We have some real estate men among our membership, although the real estate dealers have an organization of their own to which most of them belong, but our membership is composed of merchants and manufacturers, of lawyers and physicians, of men in every line of business, and our membership is a unit as to the desirablity, even the necessity of gaining access to Minnesota Point. The president of our Board of Public Works has been sent here by the unanimous vote of our City Council, composed of men from all portions of the city, and elected by people of all classes, from the laboring man on the docks to the merchant prince on the hill; the entire population of Duluth is practically unanimous in desiring the construction of this bridge and the commercial development of Minnesota Point which would follow.

The question is, can we build a bridge so that we can take advantage of Minnesota Point and at the same time not put any unwarrantable obstacle in the way of navigation? We believe that we can, and, if we find when our bridge is built, that it is obstructing navigation, we shall be the first to demand its removal. We realize the fact that the growth which we have had in the past and the greater growth which we expect for the future are based fundamentally upon our location at the western terminus of navigation. Commerce, however, is not one-sided; there is commerce on land as well as commerce on the lakes; the vessels which these gentlemen send to us over the lakes would find nothing to carry if it were not for the business created upon the land and brought down to them at the water edge by the railways.

Q. How many railroads have you in mind that will use this bridge providing it is constructed? A. There will be at least four roads which could use it, and, through a system of transfer or a general terminal system, which it is hoped to organize, it would be possible for still other roads to use it.

Q. Would not any new road have to go there practically?

A. It is pretty hard to say that a road absolutely has to go to any particular place. When I see, for instance, the way in which the Chesapeake & Ohio road has found an entrance into Cincinnati, I am not disposed to say that a railroad is compelled either to go to or to stay out of any particular place.

Q. If a tunnel can be put in there, although the cost may be several times as great, is there not interest enough in Duluth so that the tunnel migut be put in at the beginning?

Mr. Truelsen—Give us a temporary bridge there and after a while we will build a tunnel.

Q. Why can not Duluth issue bonds and build a tunnel at once?

Mr. Truelsen—I think I can answer that question; we have issued about every dollar of bonds that we are entitled to.

Adjourned until 2 p. m.

10.—CLOSING ARGUMENT OF MR. HENRY TRUELSEN PRESIDENT OF THE BOARD OF PUBLIC WORKS, DULUTH, MINN., AND OF MR. J. A. L. WADDELL, CONSULTING ENGINEER.

Gentlemen:—In making this resume of our arguments, we do not wish to impose on your good nature by repeating what has been clearly stated by our colleagues, but wish to confine our attention to certain matters that have been but lightly touched upon by them. It will be necessary, however, for us to introduce the subject by a few remarks pertaining to parts of the discussion covered by them.

To begin with, we wish to urge upon you the absolute necessity to the City of Duluth of the development of Minnesota Point. If the said City of Duluth fail to develop this point in the immediate future, she will lose a great deal of business that is now being directed her way. The various railroads that are now pointing towards Duluth will have to go elsewhere to seek terminal facilities and dockage.

Our opponents have stated that the solution of the problem is the building of a tunnel, and that in consequence the building of a bridge of any kind whatsoever across the canal ought not to be considered. In this we beg to differ from them, for it is an absolute impossibility for the City of Duluth at the present time to build such an expensive structure as a tunnel under the canal, and there is nobody that we know of that is generous enough to build it for her.

Mr. Long, in his communication, has shown very clearly that the interests at stake in the development of Minnesota Point are very great, far greater than the entire interest of the lake traffic concentrated at Duluth, so that it is evidently unfair to prevent the development of such an important piece of land as this, in which so many different parties are financially interested, merely on account of an imaginary damage to the interests of the one other party; in fact, the true interests of that party have not been really considered, because the development of Minnesota Point would mean a great increase in the lake traffic from Duluth harbor, which, of course, would be an immense gain to the very gentlemen who are opposing us so bitterly in this bridge project. Again, we would respectfully urge upon you to consider that it is incompatible with American principles that the interests of one line of business should be held to be paramount above those of all others.

In reality, there has been only one plea made by our opponents against the building of this bridge. They object to a bridge of any kind whatsoever across the canal. Not one single valid point has been made against our design, either by the opposition or by the members of your honorable Board. Moreover, the design has received indorsements from engineers and machinery-manufacturers of the highest standing, indorsements accompanied by offers to guarantee the succesful operation of the bridge, in case that the contract be awarded to the gentlemen who have offered the endorsements.

The objections of the opposition are based upon the assumption, not that the bridge would be so much an obstacle to their traffic and cause of delay, but that it would be a source of danger on account of fogs and high winds. We would respectfully state that during fogs there would be no danger at all except from culpable negligence on the part of shipmasters, because during fogs there is no wind worth mentioning, and the vessels are then under perfect control. Again, the speed of said vessels during fogs is always reduced to about 4 miles an hour when entering the harbor. Again, during the prevalence of northeast gales, vessels, when entering the harbor are, as stated by our oppenents, partially unmanageable. There would be no danger unless said vessels were trying to enter the harbor without receiving notice that the bridge is in proper working order. It would take a combination of the following circumstances to produce any danger of any magnitude:

First. The nonoperpation of the machinery at of the bridge.

Second. A northeast gale of such magnitude as to render vessels partially unmanageable.

Now, it has been shown by Mr. Bryan, chief engineer of the Hale Elevator Company, in evidence given before your honorable board, that after similar machinery manufactured by his company has been put in thorough working order the stoppage of the working of same in three years has been only 1 per cent—that is, of 300 plants in use only three of them have stopped working at all in the last three years, and that in these csses the reason for such stoppage was neglect of proper precaution and care of the machinery. Setting aside the fact that on account of the importance of this structure in respect to navigation, the care exercised would be unusually great, it would be an error on the safe side to assume that the probability of stoppage would be the same as in the case of the elevators built by the Hale Elevator Company. Again, it is perfectly proper to assume that as far as the counter-balance weights, chains and wheels are concerned, no accident to these parts can possibly occur, the design for them being of such a simple character.

It is not an exaggeration to state that there is no more chance of anything occurring to prevent the bridge being pushed up or down by some means or other than there is of the Brooklyn bridge failing *in toto*. Now, under the worst possible circumstances, viz.: the entire breaking down, not only of the ordinary operating machinery, but also of the duplicate parts, the bridge can surely be raised by hand power in less than half an hour. Taking therefore a period of time equal to three years, it is fair to assume from Mr. Bryan's experience that there will not be more than one stoppage in this time, and in all probability not that. Granting that there would be one stoppage, the ratio of time when the bridge is out of order to the total time that it is order in during navigation will be 1-30240.

Again, from an experience of twenty-three years we are enabled to state that there are not more than three days out of each season of navigation when northeast gales are of such strength as to render vessels at all unmanageable, that is during 1-70 of the time of navigation these storms would exist. Now, the chances of a stoppage of the machinery occurring at the same time with one of these great storms would be the product of these two quantities: $\frac{1}{30240} \times \frac{1}{70} = \frac{1}{2116800}$. This reduces the real danger to navigation from our proposed structure *to merely the shadow of a shade*.

The citizens of Duluth are so earnest in their desire to build the lift bridge that they are willing to concede anything in reason to navigation interests, and the committee appointed to meet your honorable Board has already at various times made the following concessions:

First. The City of Duluth will postpone the building of the span across the canal until after the close of navigation, and will operate the bridge as many times as it is required during the close of said navigation in order to make sure that every portion of the machinery is perfect, and that the counterbalance and operating cables have taken their greatest stretch. After operating the bridge thus to their own satisfaction they would ask an inspection of same by a duly authorized officer of the War Department, and not until a favorable report be obtained from said officer would the bridge be lowered during the season the of navigation.

Second. In stormy weather at night the City of Duluth would keep the bridge open.

Third. During the unusual northeast storms, accompanied by snow, the City of Duluth would keep the bridge open even in the daytime.

Fourth. If, in the future, on account of the development of the shipping from the port of Duluth, the bridge be proved to be an obstacle to navigation, the City of Duluth will agree to use it only as a winter bridge, and during the season of navigation to keep it at its extreme height. The city is ready to enter into contract and to give bond to either the United States Government or the Lake Shippers' Associations, as to the fulfillment of the terms of this proposition.

Fifth. The City of Duluth agrees to adopt every practicable safeguard against accidents to all parts of the operating machinery, and will provide the most approved methods of signaling.

In conclusion, we will again repeat that the interests of Duluth are identical with the true interests of vessel-owners, and that, as stated before verbally to your Board, the City of Duluth would not for selfish interests permit the bridge to remain if it should prove to be an obstruction to the harbor.

Trusting that you will give our arguments due consideration, and that you will not permit the imaginary dangers prophesied by our opponents to outweigh the good and substantial reasons which we have presented for the building of the bridge, we remain, gentlemen,

Very respectfully, yours,

HENRY TRUELSEN,

President of the Board of Public Works of the City of Duluth.

J. A. L. WADDELL,

Consulting Bridge Engineer.

The BOARD OF UNITED STATES ENGINEERS.

LETTER FROM MR. J. A. L. WADDELL.

CHICAGO, March 24, 1892.

DEAR SIR: In the hurry of dictating yesterday our resume of arguments before your Board, I made an error in the calculation of probabilities of accident to the bridge, although the result was not far from right. As the method employed will not bear a mathematical investigation, I request that you will substitute for it the following, which will bear such investigation, although some of the assumed probabilities may be disputed.

I have consulted Mr. Bryan, chief engineer of the Hale Elevator Company, concerning probababilities Nos. 1 and 2, and he states that they are, as nearly as may be, correct.

PROBABILITY NO. 1.

With only ordinary care and without duplicate machinery, the probability of any elevator built by the Hale Elevator Company getting out of order in 36 months, after having been once put in good shape, is 1-100.

PROBABILITY NO. 2.

On account of the duplicate machinery in our proposed bridge and because of the unusual care that will be given it on account of its important position in respect to navigation, the preceding probability should be multiplied by the ratio of 1-10. We will call this probability No. 2.

PROBABILITY No. 3.

The number of days in one season of navigation (namely, seven months) during which heavy northeast gales are blowing is three, making the probability of such a gale blowing at any time equal to 1-70.

PROBABILITY No. 4.

The probability of a vessel's wanting to get into the harbor during the half hour of stoppage will be about ¼.

PROBABILITY No. 5.

The probability of said vessel's getting too close to stop before perceiving the signals will be, say, 1-10.

The total probability of accident during 36 months (or say five years of navigation) will, therefore, be the continued product of all five of these probabilities, namely, 1-2800000.

Very respectfully yours,

J. A. L. WADDELL,
Consulting Bridge Engineer.

GEN. O. M. POE,
Chairman of Board of U. S. Engineers.

11. ARGUMENT OF MR. J. W. MILLER, HARBORMASTER, PORT OF DULUTH.

Duluth is the easiest port in the world to get in and out of. The heaviest gale that blows there is from the northeast. Vessels in coming up the lakes before one of these heavy northeast gales of wind have a port directly under their lee, and they do not have to alter their course one point to get into, and when they get there in fifteen minutes from rough water to smooth, makes it one of the easiest ports in the world to get into and out of. There is certainly no port on the lakes that is as easily accessible in a gale of wind as the port of Duluth. In all of my thirty years' experience as sailing master all over the world I have never seen a port its equal.

Very respectfully,

J. W. MILLER.

To the HONORABLE BOARD OF UNITED STATES ENGINEERS.

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12. PROTEST OF CAPT. ALEX. M'DOUGALL AGAINST BRIDGING ENTRY TO DULUTH HARBOR.

DULUTH, MINN., March 1, 1892.

DEAR SIR: I have been prominently connected with the village, city, and harbor of Duluth since its beginning twenty-two years ago, and foremost in promoting anything in the interest of its harbor, and for ten of these years was master of one of the largest steamers trading to this port. My home and all my property are located within half a mile of the canal where the proposed bridge is to be located and if the city should get any direct benefit from such a bridge my property would become more valuable from the same cause.

I explain the above facts to show my relation to the City of Duluth before commencing to tell why we should not have a bridge across this canal entry at present.

1. We must have new piers and a wider and deeper channel before any charter should be given for a bridge at this point.

2. There are only about 200 people on the strip of land or island that is to be connected by this bridge,, and apparently this island is not yet needed very badly for building and dock purposes, as there is yet a great abundance of dock frontage unoccupied; but doubtless the promoters of this enterprise are people who have some political influence in the city and who own most of the property on the island of Park Point and want to increase its value by hampering the shipping interests with a serious obstruction and load the city with the expense of building such bridge, etc.

3. Please look at a chart of Lake Superior and you will see that from 350 miles in a northeasterly direction there is a clear sweep for the terrible storms we at times get, which usually come late in the fall, and you will also see by the chart how the lake forms into a funnel-shaped westerly end, with deep water close into the mouth of this short canal or entry, so that the great deep and solid waves carry right into and through the entry, so that when we get one of the severe storms referred to vessels can not lie at any of the docks inside of the harbor that are directly opposite or near the canal, so great are the waves and swell that enter or run through into the inner harbor.

In a moderate storm, such as we get about every year, I think it would not be safe to have a bridge across this entry; but think of some of the storms we have had in the past, and we are almost certain that the like will occur again, and perhaps more severe. Since 1881 we have had no severe storms. At that time there were less than 6,000 people at the head of the lakes —both sides; now there are about 75,000, so that only a small per cent of our population ever saw one of the big "northeasters" that occurred previous to 1881. We had one in 1870, two in 1871, which carried away our breakwater, and two vessels and one steamer went ashore; and a number of other storms up until 1881, chief among which was the great storm of 1880, when all vessels were driven back for more than 200 miles to this harbor. Fortunately all entered safely, but with narrow escapes from landing on top of the piers. One vessel in particular, during that storm, entered the piers all right, but when about half way it was thrown partly up on the canal bank, and the shock she received unshipped her anchor, parted the cable and hurled it across the canal bank, but the vessel came in safely, and this great anchor, weighing a ton and a half, was found some days after away up on the canal bank, where it had been hurled from this vessel. During this storm, or some storm soon after, the steamer Siskiwit, on entering the canal piers, was thrown on the pier or canal bank once or twice and miraculously escaped from drowning all hands.

During some of the severe storms referred to, I came into the harbor as master of different steamers, and I assure you those were some of the most anxious moments of my life while doing so. I distinctly remember one storm, while captain of the steamer Hiawatha, that I was out in and came through this canal, and for two days thereafter no vessel could be unloaded in the inner harbor so great was the swell coming in through the canal. A lot of us went over to the canal, and while there made estimates of the height of the waves at the point they now propose to put this bridge, and to the best of my recollection the waves were running in through this entry, at least 12 feet above the canal piers, and were rolling on top of the canal banks on both sides for more than 50 feet, and if there were any obstructions on the piers or canal banks against which these waves could strike I fully believe the spray would go 50 feet or more in the air. The canal bank is about 7 feet above mean level of the channel. The large area inside, including Duluth harbor proper, Superior and St. Louis bays, having its outlet through this narrow channel, during storms or local winds, the current at times is very strong running in and out of this entry, and I have often seen the current going out at the rate of 6 or 7 miles per hour, and in half an hour again running in as fast. When such current is running out and meeting such waves as I have tried to describe, you can imagine what a sea it would make.

These northeast storms occur more frequently late in the fall, and usually have more or less snow with them, and at that season of the year the commerce trading here is greater, owing to the marketing of the wheat crop of the Northwest. The steamers and vessels at this time of the year usually get hold of the north shore and follow along close by it, as this shore is quite bold and easier seen when weather clears up a little. This course usually carries them well to the northward of the

Apostle Islands, and there being no good harbor or anchorage near the head of Lake Superior, they are compelled to come to this port, and should both the east and west bound fleets be caught in one of these severe northeast storms late in the fall when the temperature is down to zero, or lower, and be driven back before it and then find that through the action of the wind and waves the gear or mechanism of such bridge had become clogged and frozen up with ice so that it could not be opened and this great fleet coming, for on they must come, think of what a terrible calamity might happen if one ship was sunk there how many more might pile on top of each other.

Through this entry, and across which they propose to put this obstruction, all the commerce of Duluth, West Superior, West Duluth, and all the shipping of the upper bay and river will pass, and during storms all the shipping of Old Superior will pass in and out through this entry.

During the season of 1891 there was almost 4,000,000 tons of freight passed in and out this entry and there was engaged in this trade over 200 steamers and vessels, worth more than $30,000,000, and the rate of increase yearly is marvelous; and the idea that such a channel should be obstructed and so much vessel property endanged simply to advance the interest of a few real-estate speculators, is ridiculous in the extreme.

Very truly, yours, ALEX. McDOUGALL.

Col. O. M. Poe,
Senior Member of Board, etc.

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13. OBJECTIONS OF THE CLEVELAND VESSEL OWNERS' ASSOCIATION TO THE PROPOSED BRIDGING OF THE CANAL AT THE ENTRANCE TO THE HARBOR OF DULUTH.

Cleveland, March 19, 1892.

The Cleveland Vessel Owners' Association respectfully urges that the necessary permission to build a bridge at this place should be refused.

That the shippers of Duluth should have the use of all available territory for building elevators and warehouses is willingly conceded, but we submit that, considering the territory available at other points in and about Duluth than in the place proposed to be reached by this bridge, the question of safety in entering the harbor is of the greater importance.

The harbor of Duluth is a difficult one to enter because of the full exposure of the entrance to the northeasterly winds and seas. Vessels, and especially tows, approaching the harbor are often compelled to keep on after they have reached the earliest point at which they could possibly be informed as to whether the bridge were open or closed.

In such a case if the bridge were closed the situation would be one of great danger, inviting almost certain disaster.

In the spring and in the fall northeasterly gales are common in that locality. There is no shelter, and no alternative presents itself to the steamer or other vessel approaching the harbor. It is the experience of nearly every vessel master trading much to Duluth that at some time in each season he is compelled to approach Duluth and enter the harbor under circumstances which involve quite enough of risk under present conditions, and in which the presence of a bridge which might happen to be closed would make collision with such bridge unavoidable.

It is simple enough for parties interested in the proposed land improvement to minimize this danger, but the fact stands that Duluth is at present a difficult harbor to enter, and under certain conditions a very dangerous one. A glance at the chart showing the sweep of the northeasterly winds, taken in connection with the scant width of the entrance, is enough to establish this point.

With so large a body of water outside and the considerable body of water inside, the height of which is materially and rapidly affected by the wind and seas outside, the canal is often like a mill-race, with a heavy current running one way or the other, indifferently, according to the weather and the other causes creating a current.

We truly believe that a more difficult and dangerous place, and hence a worse place for the erection of such a bridge could hardly be found.

It is well enough to argue that the bridge should be open except when trains are passing over it, but the very reasons for establishing it at all are based upon the great amount of railway business which would be accommodated on the territory proposed to be reached and opened by bridging.

If the business should be inconsiderable, then it is not worth while to erect so dangerous an obstruction to accommodate it. If that business, however, shall be considerable, then a great and constantly increasing number of cars and switch engines would have to pass by day and by night, in fair weather and foul; and if the bridge were authorized, a constant and serious and growing menace and danger to navigation will have been established by governmental authority, and this at a time when the most anxious and urgent appeals are being made to Government for the removal of obstacles from our waterways.

Duluth should take warning from the recent blockade of the Sault Lock and at Lake George, and should consider the consequences to her commerce of a collision with such a bridge, resulting, as it most probably would, in the sinking of both bridge and vessel in this narrow channel.

It is fair also that other means of attaining the object proposed be considered exhaustively. There was once a suggestion of building a high bridge, so high that it could not interfere with navigation. Another suggestion was to reach this territory by tunnel. Still another plan suggested is to build a trestlework, with draw, through the inner harbor. It would be an inconvenience certainly even there, but a good, proper plan of construction would leave no undue risk or danger attendant. Ferry boats could be employed. Any one of these plans would enable the property to be used without unfairly infringing the rights of any interests. Possibly it would not be so convenient, so easy, or so economical for the promoters of the bridge project in the accomplishment of their ends, but that is not, after all, the prime consideration.

We urge upon your honorable Board this consideration: That parties having a deep and direct financial interest in such a bridge may be expected naturally enough to present in strong force their reasons, while the general interests, diversified and scattered, which would be seriously injured and hampered by the building of the bridge, have to look to the Government authorities having such matters under their charge to watch all such projects with jealous care that our waterways be kept clear of artificial obstructions.

We content ourselves, therefore, with submitting our objections in brief form, knowing the familiarity of the members of this Board with the general facts and the general conditions of navigation at Duluth and the head of Lake Superior, and we respectfully urge that the leave requested be refused or reported on adversely.

CLEVELAND VESSEL OWNERS' ASSOCIATION.
By Geo. P. McKay, Secretary.

The Honorable Board of U. S. Engineers.

14. ARGUMENT OF LAKE CARRIERS' ASSOCIATION BY ITS DELEGATES, W. LIVINGSTONE. JR., JAMES DAVIDSON AND CHARLES H. KEEP.

The undersigned, delegates of the Lake Carriers' Association, appointed at the annual meeting of the association held in Buffalo March 3, 1892, to attend this hearing in opposition to the proposed bridge across the Duluth Harbor entrance, do, in behalf of the association, whose delegates we are, hereby respectfully present to this Board and the Honorable Secretary of War our reasons for opposing the location of the proposed bridge.

In presenting these reasons, we speak as the authorized representatives of 300,000 registered tons of vessel property owned at all the important lake ports between Ogdensburg, on the east, and Superior and Milwaukee on the west. The tonnage we represent comprises both steam and sailing vessels and is of a value of more than $25,000,000.

First. No bridge should span the entrance to Duluth Harbor, because that entrance is now a dangerous one, and to place a bridge across would greatly enhance its dangerous character. The canal which forms the entrance to Duluth Harbor is only 250 feet wide. Its outside entrance is not protected by an extensive breakwater, as is the case at most lake harbors. In the time of heavy easterly gales it is a difficult and dangerous feat to bring a big and unwieldy vessel safely in between the piers and to navigate her safely through the canal. With vessels getting every year larger, with length and beam even now rapidly increasing, with increasing depth to come with the completion of improvements to be authorized in the immediate future, the class of vessels soon to enter this canal will equal in bulk and weight the great Atlantic liners. To bring such vessels into Duluth Harbor in rough weather is difficult enough with an unobstructed canal. A good speed must be maintained without interruption until the canal has been passed. In northeast gales a heavy current sets out between the piers, and a vessel is unmanageable, unless a high rate of speed is maintained. Vessels of today, much less vessels of ten years hence, can not be brought to a stop in entering or passing the canal in heavy easterly weather. Should such a narrow canal, forming the entrance to a most important port, entirely unproteced by a breakwater, which vessels must enter under good headway, which they must pass through at a fair rate of speed, if they are to escape serious damage from striking on the northwesterly bank—should such a canal be obstructed by a low swing or lift bridge, whose machinery is subject to derangement or which from a multitude of causes might remain to obstruct the passage at a critical moment?

We emphatically insist that it should not. The proposition seems to us as preposterous as if it had been proposed to put a drawbridge across the Buffalo piers before the construction of a breakwater at that point, or across the piers at any other important lake port where no breakwater exists.

Second. The business entering that harbor at the head of Lake Superior, great as it is, is yet in its infancy, and it is nothing to what it must become in the near future.

This little canal is destined to become one of the world's great concentrating points in shipping.

The country behind and tributary to the head of Lake Superior has just begun its development. As it fills up the grain and flour finding water shipment there must increase many fold. The return cargoes of coal and merchandise will increase in the same ratio. A new range of iron ore in close proximity to the head of Lake Superior will only add to the return cargoes seeking Duluth.

Great as the lake trade now is, those who know it best know that it is destined to grow immensely, and they expect that growth, whether it be in the carriage of coal, grain, flour, merchandise, or ore, to come very largely from the head of Lake Superior.

We ask you to look to the future as well as to the present; to remember that the entrance to Duluth harbor once bridged must remain so forever, and that as that harbor entrance becomes more inadequate to the demands of trade the proposed bridge will not only always be a factor creating such inadequacy, but will, possibly, also be in itself an obstacle to the widening or other improvement of the canal itself.

Third. An important navigable water like this canal, through which passes an immense tonnage of commerce contributed by a dozen States, should not be obstructed by another stream of commerce unless such obstruction is an absolute necessity. Is the proposed bridge to serve so important a purpose as to justify its existence? Surely that question is directly in issue on this inquiry. Upon this point we submit the following considerations:

First. That there is plenty of room for docks, slips, etc., for many years to come at places other than Minnesota Point. (See Harbor lines established for Duluth Harbor.)

Second. That the proposed bridge is a scheme in the interest of a few land holders on Minnesota Point, whose property would doubtless be greatly enhanced in value by its construction, rather than the interests of a great commerce like that which it obstructs.

Third. That if Minnesota Point must be connected with the mainland, it should be done in any other way than the construction of a low bridge across the canal entrance. Even a bridge and draw across the inside bay is infinitely preferable. Vessels could pass through such a draw with safety, but vessels approaching Duluth from outside, in an easterly gale at night, would be unneccessarily imperiled by the construction of the bridge proposed.

In conclusion, we ask your honorable Board to report against the location of any low swing or lift bridge across the canal entrance of Duluth Harbor.

Very respectfully submitted.

W. LIVINGSTONE, JR.,
JAMES DAVIDSON,
CHARLES H. KEEP,
Delegates Lake Carriers' Association.

To the honorable BOARD OF ENGINEERS.

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15. TELEGRAM FROM EDWARD SMITH AND OTHERS, VESSEL OWNERS, OF BUFFALO, N. Y.

BUFFALO, N. Y., March 21, 1892.

As protest against Duluth Canal bridge. Many of the vesselmen and most of the old citizens of Duluth have seen the fury of the northeast gales throwing the riprap rock of many tons weight over the small part of old breakwater outside harbor, Duluth, which is evidence of that funnel-shaped end of Lake Superior being the worst storm-affected part of the Great Lakes, and the danger of placing a bridge in a channel so dangerously affected, we protest against.

EDWARD SMITH,
BROWN & CO.,
JOHN RICE,
JOHN DONALDSON,
GEORGE McLEOD,
Vessel Owners.

Gen. O. M. Poe.

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16. PROTEST OF VESSEL OWNERS OF MILWAUKEE, WIS.

Milwaukee. Wis., January, 1892.

Sir: We, the undersigned, respectfully request that the plan for a lift bridge across the ship canal at Duluth, Minn., which is about to be laid before the Department by the Common Council of the City of Duluth, be not approved, on account of the dangerous position our vessels will be placed in in entering the harbor of Duluth.

The tallest masts on the lakes being 160 feet high, and allowing 6 feet for the heaving of the vessel in rough weather, no less clear height above the water than 166 feet will be needed. The hoisting up of such a large structure to this height will be too slow and unsafe an operation in itself, and we certainly object to risk lives and property by running under such a heavy mass, suspended some 200 feet in the air, at a place where the east gales blow with uninterrupted force.

The building of the above-mentioned bridge we therefore consider an obstruction to navigation, and that, too, at one of the most important harbors on the lakes, and we most respectfully ask that our protest receive due consideration.

Respectfully,

JAS. LEISK, Steamer Helena,
AND SEVENTEEN OTHERS.

Hon. S. B. ELKINS,
Secretary of War.

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17. LETTER FROM THE GENERAL MANAGER OF THE LAKE MICHIGAN AND LAKE SUPERIOR TRANSPORTATION COMPANY.

LAKE MICHIGAN AND LAKE SUPERIOR TRANSPORTATION CO.,
Chicago, February 27, 1892.

DEAR SIR: Referring to your notice in reference to the application made to the Secretary of War by the municipal authorities of the City of Duluth, Minn., for permission to bridge the canal at entrance of harbor at that place. I herewith beg to express, in behalf of the Lake Michigan and Lake Superior Transportation Company, my decided disapproval to encumbering the entrance to Duluth Harbor with a bridge such as proposed.

If considered that the canal referred to is in immediate proximity to Lake Superior, and for which reason I would regard a bridge there of great danger to vessels entering, especially in certain weather, it is obvious to anyone acquainted with the situation there that such a bridge as proposed would be a continuous menace to every vessel entering Duluth Harbor, and, therefore, should not be built.

Yours, very respectfully,

JOSEPH AUSTRIAN,
General Manager.

Capt. W. L. FISK,
Corps of Engineers.

18. LETTER OF MR. F. C. H. ARENTZ AND MR. L. E. SANGDAHL.

MILWAUKEE, Wis., February 18, 1892.

DEAR SIR: A note in the Duluth Daily News of February 6 stated that the plans for the proposed bridge across the canal there have been referred for examination to a Board of Engineers, of which yourself are the senior member.

As we are taking part in the competition for plans, we are of course much interested in the result of the investigation, so much the more as we were awarded the prize for the best and most complete plans.

Two members of the Board of Public Works of Duluth, however, are making strong efforts to get a cheaper design adopted, one that is entirely different from what was asked for, and one that in the minds of most people looks like a very risky experiment, and it has been intimated that none but this plan was laid before the Secretary of War. We are inclined to think that there are other motives than that of economy which is prompting the Board to such peculiar actions after the prize has been awarded to us; the public's interest is sometimes sacrificed for personal and political interests.

We do not solicit favoritism, but wish to stand on the merits of our design, and would be pleased to see also our plans laid before the examing board. A call for it might produce it, otherwise it would most likely be kept away from you.

You will probably remember Mr. Sangdahl, from Detroit, where he was superintending the construction of the Belle Isle bridge in the capacity of engineer for the Milwaukee Bridge and Iron Works.

Respectfully yours,

F. C. H. ARENTZ,
L. E. SANGDAHL.
Per F. C. H. A.

Col. O. M. POE,
United States Engineer.

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